Missouri Department of Natural Resources

Biological Assessment Study

Upper North Fork of the Spring River
Barton and Dade Counties

2003 - 2004

Prepared for:

Missouri Department of Natural Resources
Water Protection and Soil Conservation Division
Water Protection Program
Water Pollution Control Branch

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Environmental Services Program
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1.0 Introduction

At the request of the Missouri Department of Natural Resources (**MDNR**), Water Protection Program (**WPP**), Water Pollution Control Branch (**WPCB**), the Environmental Services Program (**ESP**), Water Quality Monitoring Section (**WQMS**) conducted a macroinvertebrate bioassessment of the North Fork of the Spring River in Barton and Dade counties. A twenty-four mile segment of the North Fork of the Spring River that flows from just upstream of Golden City to Lamar was assessed. Four stations were sampled in the fall 2003 sampling season and five stations were sampled during the spring 2004 sampling season. Coon Creek, a class C tributary of North Fork of the Spring River, was also sampled as a test station during the spring 2004 sampling season since it was not on the 1998 303(d) list and had a similar watershed size to the upper test stations on North Fork of the Spring River. These stations were compared to biological criteria calculated from two ecoregion transitional biocriteria riffle-pool reference streams (Cedar Creek, Cedar County and Horse Creek, Cedar County) from the Ozark/Osage Ecological Drainage Unit (**EDU**).

1.1 Study Area/Justification

North Fork of the Spring River originates in western Dade County near the town of Golden City and is located within the Ozark/Elk/Spring Ecological Drainage Unit (EDU). North Fork of the Spring River is listed in the Missouri Water Quality Standards (MDNR 2000) as a class "C" stream for its first 51.5 miles and a class "P" stream for 14.5 miles to its confluence with the Spring River in Jasper County. Designated uses for North Fork of the Spring River are "warm water aquatic life protection, human health/fish consumption and livestock and wildlife watering." The first 51.5 miles of the North Fork of the Spring River have been placed on the 1998 303(d) list for elevated levels of sediment.

The North Fork of the Spring River is a tributary of the Spring River system in southwestern Missouri that flows through a geological region that is a transitional area that has features of both the Ozark and plains ecoregions. The stream system is characterized by long pools with short, rocky and gravelly riffles and the geology in the watershed contains beds of shale, sandstone, and limestone (Pflieger, 1989). Since the North Fork of the Spring River is transitional in nature and no transitional reference streams exist in the Ozark/Elk/Spring Ecological Unit, two adjacent transitional reference streams (Cedar Creek, Cedar County and Horse Creek, Cedar County) from the Ozark/Osage Ecological Drainage Unit were used to calculate biological criteria.

In 2003, a study plan was submitted to the MDNR, WPB (Appendix A). The ESP, WQMS was responsible for the proposed bioassessment study on the North Fork of the Spring River that included the following purpose, objectives, tasks, and null hypotheses.

1.2 Purpose

The purpose of the study is to determine if the North Fork of the Spring River macroinvertebrate community is impaired. If North Fork of the Spring River is impaired, a second objective is to

determine if it is impaired by sediment deposition or if it is caused by some other water quality parameter.

1.3 Objectives

1) Determine if the Stream Condition Index (**SCI)** values calculated from biocriteria data for the Ozark/Osage EDU for two transitional reference streams (Horse and Cedar Creeks) and North Fork of the Spring River are statistically different from each other and different from the other reference streams in the Ozark/Osage EDU (Kruskal-Wallis ANOVA on Ranks and Dunn's Multiple Comparison Test).

2) Determine if the macroinvertebrate community and water quality in North Fork of the Spring River is impaired compared to the two transitional streams (Horse and Cedar Creeks).

3) Determine if the macroinvertebrate community in North Fork of the Spring River is more similar to the reference stream (Little Drywood Creek, Vernon County) in the Osage/Plains EDU or to the two transitional reference streams (Horse and Cedar Creeks, Cedar County) in the Ozark/Osage EDU using Detrended Correspondence Analysis (DCA) from data collected in habitats in common (depositional substrate in non-flowing water & rootmats).

4) Assess the habitat quality of the North Fork of the Spring River.

1.4 Tasks

1) Conduct a bioassessment of the macroinvertebrate community on the North Fork of the Spring River at four sampling stations during the fall 2003 sampling season and five sampling stations during the spring 2004 sampling season.

2) Conduct a water quality assessment at the sampling stations to determine potential water quality impacts.

3) Conduct a habitat assessment at the sampling stations to ensure comparability of aquatic habitats.

1.5 Null Hypotheses

1) The macroinvertebrate community will not differ between longitudinally separate reaches of the North Fork of the Spring River

2) The macroinvertebrate community in North Fork of the Spring River will not differ from similar sized reaches of two transitional biological reference streams (Cedar Creek, Cedar County and Horse Creek, Cedar County) in the Ozark/Osage Ecological Drainage Unit (EDU).

2.0 Methods

Carl Wakefield and Brian Nodine of the Water Quality Monitoring Section, Missouri Department of Natural Resources, Air and Land Protection Division, Environmental Services Program conducted this study.

2.1 Study Timing

Macroinvertebrate and water quality samples were collected for one fall and one spring season. Fall sampling was conducted on September 22 and 23, 2003 and spring sampling and habitat assessments were conducted on March 31 and April 1, 2004.

2.2 Station Descriptions

Figure 1 shows the location for the test stations on North Fork of the Spring River and Table 1 provides legal descriptions and descriptive information for the test stations. For quality control purposes, duplicate samples were collected at station #3 during the fall sampling season and station #4 during the spring sampling season.

Table 1
Station Number, Legal Location, and Descriptive Information for the North Fork of the Spring River Bioassessment Study

Station Number	Section, Township, Range	Description	County
North Fork Spring River #1	NW ¼, sec. 24, T. 32 N., R. 31 W.	Test-NE 5th Road in Lamar City Limits	Barton
North Fork Spring River #2	NE ¼, sec. 31, T. 32 N., R. 29 W.	Test-SE 10th road crossing	Barton
North Fork Spring River #3	NE ¼, sec. 9, T. 31 N., R. 29 W.	Test-SE 30th road crossing	Barton
North Fork Spring River #4	SE ¼, sec. 23, T. 31 N., R. 29 W.	Test-SE 60th road crossing near Golden City	Barton
North Fork Spring River #5	SW ¼, sec. 36, T. 31 N., R. 29 W.	Test-SE79th road (Dead end Road) **Sampled only during Spring 2004 Season**	Dade
Coon Creek #1	NE ¼, sec. 18, T. 30 N., R. 31 W.	Test-County Road 120 Crossing **Sampled only during Spring 2004 Season**	Jasper

Figure 1: Map of North Fork of the Spring River and Sampling Stations

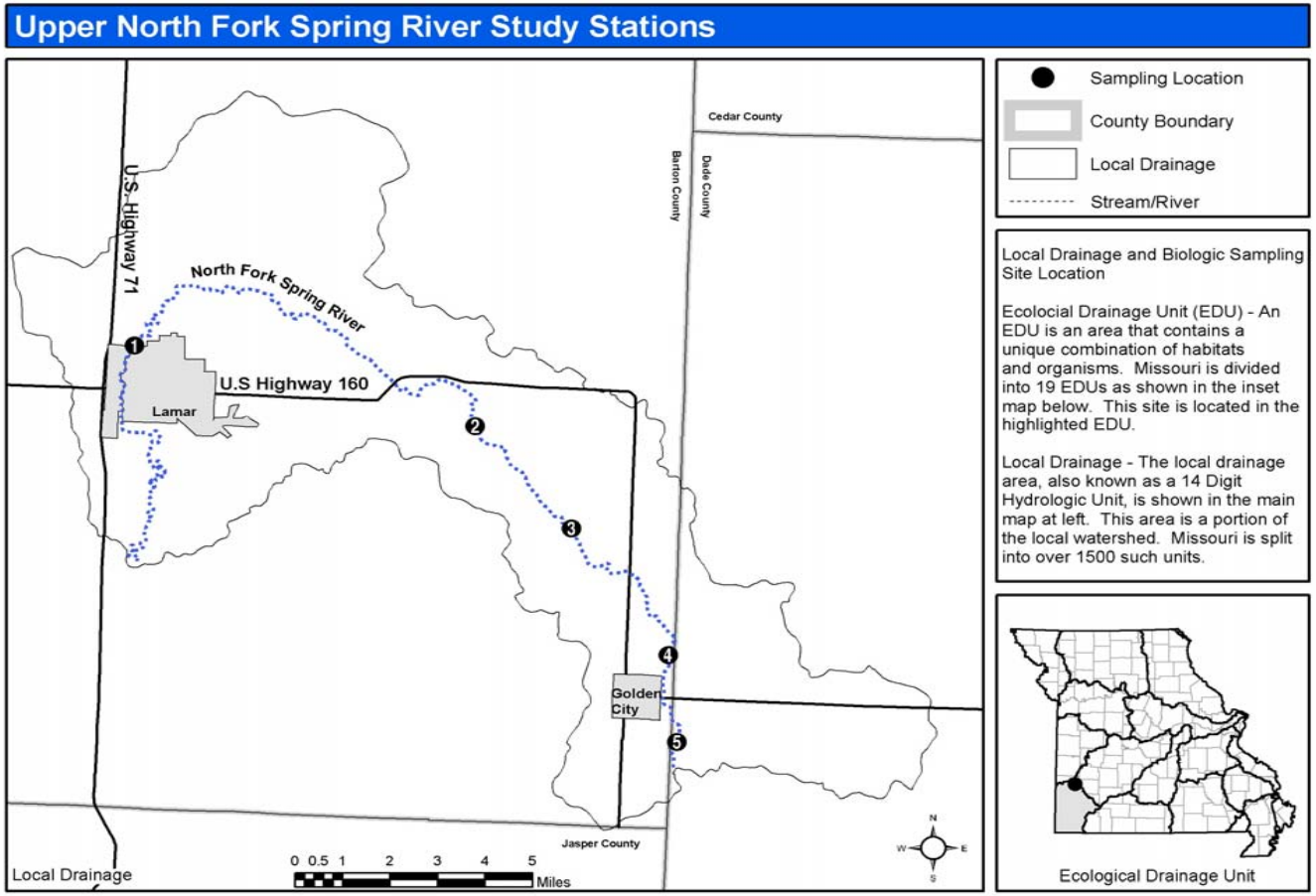

Table 2
Percent Land Cover

Land Cover	14-digit Hydrological Unit (HU)	Urban	Crops	Grassland	Forest	Swamp
Ozark/Elk/Spring EDU	Multiple Hydrological Units	0.7	5.5	67.2	25.4	0
North Fork Spring River #1	11070207060004	1.9	21.4	63.2	10.9	0
North Fork Spring River #2	11070207060003	0	19.7	64.2	15.5	0
North Fork Spring River #3	11070207060003	0	19.7	64.2	15.5	0
North Fork Spring River #4	11070207060002	0.7	12.4	81.5	4.6	0
North Fork Spring River #5	11070207060002	0.7	12.4	81.5	4.6	0
Coon Creek #1	11070207070004	0	24.6	64.8	9.8	0
Cedar Creek #1	10290106090006	0	1.6	69.9	28.1	0
Horse Creek #1	10290106090005	0	7.2	54.5	37.8	0
L. Drywood Creek	10290104060001	0	19.1	60.9	18.8	0

2.2.1 Ecological Drainage Unit

An EDU is a region in which biological communities and habitat conditions can be expected to be similar. A map of the Ozark/Elk/Spring EDU is also included in Figure 1. All test stations are within this EDU. Table 2 compares the land cover percentages from the Ozark/Elk/Spring EDU and 14-digit Hydrologic Units (**HU)**, which contain the North Fork of the Spring River test stations, the two transitional biocriteria reference streams from the Ozark/Osage EDU, and Little

Drywood Creek, a biocriteria reference stream in the Osage/Plains EDU. Land cover data were derived from Thematic Mapper satellite data from 1991 to 1993 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**). Grassland was the dominant land use of the North Fork of the Spring River watershed, Ozark/Elk/Spring EDU, the two transitional biocriteria reference streams from the Ozark/Osage EDU, and Little Drywood Creek. Cropland was much higher and forest cover was much lower at the North Fork of the Spring River, Coon Creek, and Little Drywood Creek than the Ozark/Elk/Spring EDU and the two transitional biocriteria reference streams from the Ozark/Osage EDU (Table 2).

2.3 Habitat Assessment

A standardized assessment procedure was followed as described for Riffle/Pool Habitat in the Stream Habitat Assessment Project Procedure (**SHAPP**) (2003a). The habitat assessment was conducted on all stations during the March 2004 sampling season.

2.4 Biological Assessment

Biological assessments consist of macroinvertebrate collection and physicochemical sampling for the two sample periods.

2.4.1 Macroinvertebrate Collection and Analysis

A standardized macroinvertebrate sample collection and analysis procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (2003b). Three standard habitats (flowing water over coarse substrate, depositional substrate in non-flowing water, and root-mat) were sampled at all locations.

Macroinvertebrate data were analyzed using four methods. The first analysis was using the four general biological metrics found in the SMSBPP. The four metrics used and found in the SMSBPP are: 1) Taxa Richness (**TR**); 2) Ephemeroptera/Plecoptera/Trichoptera Taxa (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SI**). The metric evaluations were done by comparing the North Fork of the Spring River sample stations on a seasonal basis to biological criteria calculated from all of the biocriteria reference streams from the Ozark/Osage EDU. North Fork of the Spring River SCI values were compared to data from the two transitional streams (Horse and Cedar Creeks) and to the other reference streams in the Ozark/Osage EDU to determine if they were statistically different from the other two data groups (Kruskal-Wallis ANOVA on Ranks and Dunn's multiple comparison test).

The second analysis recalculated the four general biological metrics using biological criteria data collected from the transitional reference streams (Horse and Cedar Creeks) in the Ozark/Osage EDU. SCI values were calculated to determine if North Fork of the Spring River was impaired compared to the two transitional reference streams.

The third analysis of the biological data was an evaluation of macroinvertebrate community composition by percent composition of different macroinvertebrate groups. Comparisons of the

macroinvertebrate community at the North Fork of the Spring River test stations and reference stations at the transitional biocriteria streams (Horse and Cedar Creeks) were made.

The fourth analysis was to determine if the macroinvertebrate community in North Fork of the Spring River was more similar to the reference stream (Little Drywood Creek, Vernon County) in the Osage/Plains EDU or to the two transitional reference streams (Horse and Cedar Creeks, Cedar County) in the Ozark/Osage EDU using Detrended Correspondence Analysis (DCA) from data collected in habitats in common (depositional substrate in non-flowing water & rootmats).

2.4.2 Physicochemical Collection and Analysis

Results are shown from physicochemical collections and analyses during each of the sampling periods during 2003 and 2004 (Tables 14 and 15).

Physicochemical samples collected in fall 2003 and spring 2004 were: pH, temperature, conductivity, dissolved oxygen, discharge, turbidity, hardness, ammonia-N, nitrate/nitrite-N, Total Kjeldahl Nitrogen (TKN), chloride, and total phosphorus. Temperature, pH, conductivity, dissolved oxygen, and discharge were conducted in the field.

All samples were collected per MDNR-FSS-001: Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003e). All samples were kept on ice until they were delivered to the ESP laboratory. The WQMS measured turbidity in the WQMS Biology Laboratory. All other samples were delivered to the ESP Chemical Analysis Section (CAS) for analyses.

Results of water quality analyses were compared to Water Quality Standards (MDNR 2000). North Fork of the Spring River is classified as a class "C" stream and a general warm-water fishery (GWWF) for the study reach. Waters designated as GWWF "allow the maintenance of a wide variety of warm-water biota, including naturally reproducing recreationally important fish species".

Two other criteria were included to identify limits. The first criterion was the reason for protection. In this case, values were identified for the "Protection of Aquatic Life". The second was the rate of exposure, such as chronic or acute exposure. This was important to determine limits for pollutants that could be tolerated by aquatic life over a period of time.

2.4.3 Discharge

Stream flow was measured using a Marsh-McBirney Flow Meter at each station and discharge was calculated as cubic feet per second (cfs). Methodology was in accordance with the standard operating procedure MDNR-WQMS 113, Flow Measurement in Open Channels (MDNR 2003d).

2.5 Data Analysis

The physicochemical data were examined by variable to identify stations that had elevated levels that were outliers or above Missouri Water Quality Standards (MDNR 2000). Sampling stations that had elevated levels of certain variables were then discussed with possible influences being identified.

2.6 Quality Control

Quality control was used as stated in the various MDNR Project Procedures and Standard Operating Procedures. Duplicate samples at sample station #3 during the fall 2003 sampling season and station #4 in the spring 2004 sampling season were collected and analyzed for macroinvertebrate and physicochemical parameters. A random number of processed macroinvertebrate collections were rechecked for missed specimens.

3.0 Results and Analysis

Three areas of interest are important to impact identification in streams. These include a physical habitat assessment, biological assessment, and physicochemical water analysis.

3.1 Habitat Assessment

Table 3 provides habitat assessment scores for North Fork of the Spring River sample stations, the Coon Creek sample station, and the Cedar Creek biocriteria reference stream station from the Ozark/Osage EDU. Data were collected in spring 2004 with Carl Wakefield and Brian Nodine performing the scoring. According to the SHAPP guidance, for a study site to fully support a biological community, the total score of the study site should be 75 to 100 percent similar to the total score of a reference site.

Some habitat category scores in the SHAPP, such as epifaunal substrate and riffle quality, indicated that the North Fork of the Spring River might not support a comparable macroinvertebrate community compared to riffle-run reference quality streams. North Fork of the Spring River had long pools and very short riffles that were primarily made up of small cobble or gravel that lacked good substrate size diversity. North Fork of the Spring River and Coon Creek sample stations scored in the poor or marginal category for percent optimal epifaunal substrate coverage with values ranging from 7.6 to 17.7 percent. Cedar Creek scored in the optimal category for epifaunal substrate with 55 percent of the sample station covered with good substrate. North Fork of the Spring River and Coon Creek scored in the marginal category for riffle quality except for North Fork of the Spring River #4 along with Cedar Creek (reference station) scoring in the suboptimal category.

Other categories in the SHAPP such as embeddedness, sediment deposition, bank stability, bank vegetative protection, and riparian zone condition indicated that sediment was not a major problem in North Fork of the Spring River and Coon Creek. Embeddedness was low and in the optimal category of the SHAPP at all of the test stations and the reference station at Cedar Creek. Sediment deposition for test stations was in the optimal or suboptimal category of the SHAPP

and ranged from 2.0 to 25.2 percent of the area in the sample reach covered by fine sediment. North Fork of the Spring River #1 (25.2% coverage) and North Fork of the Spring River #2 (21.6% coverage) along with the reference station on Cedar Creek (21.8% coverage) were the only stations that were in the suboptimal category. Most of the banks for the stations were in optimal condition based on the SHAPP. The only exceptions were the right bank of North Fork of the Spring River #1 (marginal category), right bank of North Fork of the Spring River #4 (poor category), right bank of Coon Creek #1 (marginal category), and the left bank of Cedar Creek (suboptimal category). The riparian zone was also in good condition for most of the stations. All of the stations had riparian zones scoring in the optimal range for at least one of the banks except for Coon Creek #1. The riparian of the left bank of Coon Creek was in marginal condition and the riparian zone of the right bank was in poor condition. The only other riparian zones that were not in optimal condition were the right bank of North Fork of the Spring River #1 (poor category), right bank of North Fork of the Spring River #4 (poor category), and the right bank of Cedar Creek #1 (poor category). The only category in the SHAPP that indicated sedimentation might increase in the future was vegetative protection of the stream banks. Most of the banks had little vegetative protection and were in poor condition based on the SHAPP. The only banks that were not in the poor category for vegetative protection were the right bank of North Fork of the Spring River #3 (marginal category), the left bank of North Fork of the Spring River #4 (suboptimal category), and the right bank of Coon Creek #1 (suboptimal condition).

Table 3
Habitat Assessment Scores for Transitional Biocriteria Reference Streams and Test Stations
March 2004

Transitional Reference Stream/Station	Habitat Score	Test Streams/Stations	Habitat Score	% of Reference
Cedar Creek #1	138	North Fork Spring River #1	120	87
		North Fork Spring River #2	139	101
		North Fork Spring River #3	140	101
		North Fork Spring River #4	140	101
		North Fork Spring River #5	141	102
		Coon Creek #1	126	91

3.2 Biological Assessment

3.2.1 Kruskal-Wallis ANOVA on Ranks Analysis Comparing Stream Condition Index (SCI)

The Stream Condition Index (SCI) was calculated using biocriteria data for the Ozark/Osage EDU to determine if the two transitional streams (Horse and Cedar Creeks) and North Fork of the Spring River were statistically different from each other and/or different from the other reference streams in the Ozark/Osage EDU. The median SCI value of 14 for the two transitional streams and 10 for North Fork of the Spring River were significantly lower than the median

value of 18 for the other reference streams in the Ozark/Osage EDU (Kruskal-Wallis ANOVA, $P < 0.001$; Dunn's Multiple Comparison Test, $P < 0.05$). However, there was no statistically significant difference between SCI values for North Fork of the Spring River and the two transitional streams (Dunn's Multiple Comparison Test, $P > 0.05$). See Appendix B for a printout of the statistical results. These results indicate that both North Fork of the Spring River and the two transitional reference streams have a less diverse macroinvertebrate community than the other reference streams in the Ozark/Osage EDU. The results also show that North Fork of the Spring River had lower SCI scores than the two transitional reference streams, but there was not enough difference to be statistically significant.

3.2.2 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)

The SMSBPP metric evaluation generally uses all similar classes of reference streams from an EDU to calculate numeric biocriteria. Because of the transitional nature of North Fork of the Spring River, numeric biocriteria were re-calculated using the two transitional reference streams from the Ozark/Osage EDU to provide criteria from streams located in the same transition area. The criteria are listed for the fall and spring seasons in Tables 4 and 5.

Table 4
Biological Criteria Scores Calculated From Two Transitional Biocriteria Streams in the Ozark/Osage EDU, Fall Season

	Score = 5	Score = 3	Score = 1
TR	>79	79-40	39-0
EPTT	>14	14-7	6-0
BI	<6.88	6.88-8.44	8.45-10
SI	>3.13	3.13-1.57	1.56-0

Table 5
Biological Criteria Scores Calculated From Two Transitional Biocriteria Streams in the Ozark/Osage EDU, Spring Season

	Score = 5	Score = 3	Score = 1
TR	>77	77-39	38-0
EPTT	>17	17-9	8-0
BI	<6.38	6.38-8.19	8.20-10
SI	>3.30	3.30-1.65	1.64-0

The metric values and scores for the North Fork of the Spring River from fall 2003 are presented in Table 6. Data from the fall 2003 samples showed that North Fork of the Spring River #1 had full sustainability and the rest of the sample stations had partial sustainability based on metric

scores. Taxa richness, EPT taxa, and the Shannon Diversity Index were lower and biotic index was higher at sample stations #2-#4 compared to sample station #1 (Table 6). North Fork of the Spring River #4 had lower taxa richness, EPT taxa, and Shannon Diversity Index than the other test stations.

Table 6
North Fork of the Spring River Metric Values and Scores, Using Biological Criteria Calculated From Two Transitional Biocriteria Reference Streams in the Ozark/Osage EDU
Fall 2003

Sample No./Station	TR	EPTT	BI	SI	SCI	Sustain.
03-18704						
N. Fk. Spring River #1 Value	84	10	6.83	3.42		
N. Fk. Spring River #1 Score	5	3	5	5	18	Full
03-18705						
N. Fk. Spring River #2 Value	71	6	7.59	3.14		
N. Fk. Spring River #2 Score	3	1	3	5	12	Partial
03-18706						
N. Fk. Spring River #3b Value	74	8	7.48	3.21		
N. Fk. Spring River #3a Score	3	3	3	5	14	Partial
03-18707						
N. Fk. Spring River #3b Value	66	5	7.38	3.24		
N. Fk. Spring River #3b Score	3	1	3	5	12	Partial
03-18708						
N. Fk. Spring River #4 Value	55	4	7.43	2.87		
N. Fk. Spring River #4 Score	3	1	3	3	10	Partial

The metric values and scores for the North Fork of the Spring River from spring 2004 are presented in Table 7. SCI scores for the North Fork of the Spring River test stations ranged from 10 at station #1 to 14 at station #2 and #4a. Taxa richness, EPT taxa, and Shannon Diversity Index were lower at station #1 than the other test stations on the North Fork of the Spring River. Coon Creek, a control station and a tributary of the North Fork of the Spring River, had an SCI value of 10 during the spring 2004 sampling season. It had lower values for taxa richness and the Shannon Diversity Index than all of the North Fork of the Spring River test stations.

Table 7
North Fork of the Spring River Metric Values and Scores, Using Biological Criteria Calculated From Two Transitional Biocriteria Reference Streams in the Ozark/Osage EDU
Spring 2004

Sample No./Station	TR	EPTT	BI	SI	SCI	Sustain.
04-18702						
N. Fk. Spring River #1 Value	63	7	7.12	2.73		
N. Fk. Spring River #1 Score	3	1	3	3	10	Partial
04-18703						
N. Fk. Spring River #2 Value	78	11	7.40	3.20		
N. Fk. Spring River #2 Score	5	3	3	3	14	Partial
04-18704						
N. Fk. Spring River #3 Value	76	8	6.97	3.18		
N. Fk. Spring River #3 Score	3	3	3	3	12	Partial
04-18705						
N. Fk. Spring River #4a Value	79	9	6.81	3.17		
N. Fk. Spring River #4b Score	5	3	3	3	14	Partial
04-18706						
N. Fk. Spring River #4b Value	77	9	6.74	3.08		
N. Fk. Spring River #4b Score	3	3	3	3	12	Partial
04-18707						
N. Fk. Spring River #5 Value	70	10	6.80	3.04		
N. Fk. Spring River #5 Score	3	3	3	3	12	Partial
04-18708						
Coon Creek #1 Value	54	7	6.74	2.51		
Coon Creek #1 Score	3	1	3	3	10	Partial

3.2.3 Macroinvertebrate Percent and Community Composition

The number for taxa richness, EPT taxa, percent Ephemeroptera, percent Plecoptera, percent Trichoptera, and percent composition for the five dominant macroinvertebrate families and taxa at each station are presented in Tables 8, 10, and 11. Values in the tables in bold type represent the five dominant macroinvertebrate families and taxa for each station. Mean and standard deviation (SD) values for taxa richness, EPT taxa, percent EPT, and percent composition of the dominant macroinvertebrate families from the macroinvertebrate samples from the North Fork of the Spring River test stations and the Horse and Cedar Creek reference stations are presented in Tables 9 and 12.

Fall 2003 macroinvertebrate samples from North Fork of the Spring River showed that Ephemeroptera and Trichoptera relative abundance were much higher at station #1 than the other sample stations (Table 8). Mayflies from the families Baetidae and Caenidae made up most of the increased abundance of Ephemeroptera at sample station #1. Chironomids, Tubificid worms, and Elmid beetles were abundant at all the North Fork of the Spring River test stations and the Cedar Creek reference station. Elmid beetles, mostly from the genus *Stenelmis,* were much more abundant at sample stations #2-#4 than sample station #1. *Acerpenna*, *Caenis* l*atipennis*, *Polypedilum convictum* group, and *Tanytarsus* were more abundant at sample station #1 while *Glyptotendipes*, *Chironomus*, *Kiefferulus*, *Chaoborous*, and *Menetus* were more abundant at sample stations #2-#4 (Table 8). *Caenis latipennis, Polypedilum convictum,* and *Tanytarsus* were also more abundant at Cedar Creek than North Fork of the Spring River stations #2-#4. Taxa with high biotic index values, and possible indicators of low dissolved oxygen levels during low flow, such as *Glyptotendipes, Kiefferulus, Polypedilum illinoense* group, *Procladius*, and *Chaoborus* were generally higher in relative abundance at the North Fork of the Spring River test stations than the Cedar Creek reference station.

Mean values for fall data comparing North Fork of the Spring River test stations and Horse and Cedar Creeks showed that taxa richness was slightly lower and EPT and percent EPT was much lower at the North Fork of the Spring River test stations than at the Horse and Cedar Creek test stations (Table 9). Mayfly families such as Caenidae and Heptageniidae were present at both North Fork of the Spring River and Horse and Cedar Creeks, but in much higher relative abundance at Horse and Cedar Creeks. Elmidae, Tubificidae, Planorbidae, Sphaeriidae, and Scirtidae were higher in relative abundance at the North Fork of the Spring River test stations than Horse and Cedar Creeks. Some taxa that were present in high abundance in a few samples and very low in the rest of the samples such as Hydropsychiidae from Horse and Cedar Creeks and Baetidae from North Fork of the Spring River had higher standard deviation (SD) values than the mean value. Since these taxa were not indicative of the entire comparison groups (test and reference), no comparisons were made between these groups.

Spring 2004 macroinvertebrate samples showed that more mayflies were present in the three most downstream stations than the two upstream stations in North Fork of the Spring River and the Coon Creek station, even though the abundance in the downstream stations of North Fork of the Spring River were low compared to the Cedar Creek reference station (Table 10). Stoneflies were more abundant at the two most upstream stations on North Fork of the Spring River and Coon Creek than the three downstream stations and were at levels comparable to stonefly abundance in the Cedar Creek reference station. Caddisfly abundance was much lower at all of the North Fork of the Spring River stations and the Coon Creek station compared to the Cedar Creek reference station. *Caenis latipennis* was the most abundant mayfly taxa and *Perlesta* was the most abundant stonefly taxa in all of the samples (Table 11). Other mayfly taxa such as *Stenonema femoratum* and *Stenacron* were in very low abundance in the North Fork of the Spring River samples. Tubificidae, Chironomidae, and Simuliidae were the most abundant taxa found in most of the North of the Spring River samples (Table 10). Tubificidae and Simuliidae

had higher abundance at North Fork of the Spring River test station #1 than the other North Fork test stations, Coon Creek, and the Cedar Creek reference station. Immature tubificidae and *Limnodrilus hoffmeisteri* were abundant in coarse substrate and non-flow habitats in the North Fork of the Spring River samples with a trend of increasing relative abundance going from upstream to downstream sample stations (Table 11). Chironomid taxa such as *Crictopus/Orthocladius*, *Hydrobaenus*, and *Eukiefferiella* were abundant in the North Fork of the Spring River test stations and the Coon Creek control station, whereas *Polypedilum convictum* group were more abundant in the Cedar Creek reference station. *Eukiefferiella* was much more abundant in the three most upstream North Fork of the Spring River test stations compared to the two upstream test stations.

Mean values for spring data comparing North Fork of the Spring River test stations and Horse and Cedar Creeks showed that taxa richness was slightly lower and EPT taxa and percent EPT were much lower at the North Fork of the Spring River test stations (Table 12). Caenidae, Hyalellidae, Perlidae, and Perlodidae were more abundant at Horse and Cedar Creek reference stations, while Tubificidae, Elmidae, Simuliidae, and Asellidae were more abundant at the North Fork of the Spring River test stations.

Table 8
North Fork of the Spring River Test Stations, Coon Creek Control Station, and Cedar Creek Reference Station, Macroinvertebrate Family and Taxa Composition per Station, Fall 2003

Variable-Station	N. Fk. Spring River #1	N. Fk. Spring River #2	N. Fk. Spring River #3a	N. Fk. Spring River #3b	N. Fk. Spring River #4	Cedar Creek #1
Macro Sample Number	03-18704	03-18705	03-18706	03-18707	03-18708	03-18709
Taxa Richness	84	71	74	66	55	85
Number EPT Taxa	10	6	8	5	4	14
% Ephemeroptera	20.2	5.0	4.9	6.6	3.4	14.6
% Plecoptera	0	0	0	0	0	0
% Trichoptera	2.7	0.1	0.6	0.5	0	0.9
% Dominant Macroinvertebrate Families						
Chironomidae	**37.1**	**50.8**	**32.1**	**29.9**	**15.6**	**37.3**
Baetidae	**13.8**	0.4	0.2	0	0.4	2.0
Tubificidae	**10.0**	**8.0**	**13.8**	**9.5**	**17.4**	**8.9**
Elmidae	**7.1**	**17.2**	**24.3**	**21.9**	**30.2**	**21.1**
Hyalellidae	**5.9**	1.4	**8.5**	**12.1**	1.0	3.1
Scirtidae	1.3	**4.3**	0.5	0.3	1.4	0.2
Sphaeriidae	4.9	**2.8**	2.5	2.7	**5.4**	2.2
Coenagrionidae	1.9	0.5	**3.6**	3.5	0.9	1.3
Caenidae	4.1	1.1	2.9	**4.0**	**1.5**	**5.1**
Planorbidae	0.8	1.1	1.0	2.5	**6.0**	0.4
Heptageniidae	1.3	0.9	1.3	1.0	0.8	**6.0**
% Dominant Macroinvertebrate Taxa						
Acerpenna	**12.3**	0.2	0	0	0	0.4
Immature Tubificidae	**9.9**	**5.1**	**9.8**	**7.1**	**16.5**	**7.9**
Polypedilum convictum grp.	**7.5**	1.2	0.6	0.3	0.3	4.2
Stenelmis	**6.4**	**15.8**	**20.2**	**17.5**	**27.2**	**20.9**
Tanytarsus	**6.3**	3.7	2.7	2.3	1.5	**8.1**
Glyptotendipes	1.7	**16.9**	**6.0**	**6.3**	1.7	2.3
Chironomus	1.3	**7.8**	2.5	2.7	2.4	3.8
Kiefferulus	0	**5.4**	0.2	0.1	3.4	0.1
Hyalella azteca	5.9	1.4	**8.5**	**12.1**	1.0	3.1
Polypedilum illinoense grp.	4.0	4.7	**4.7**	2.3	0.8	0.8
Procladius	4.0	2.1	3.6	**5.4**	0.8	1.5
Sphaerium	4.6	2.8	2.5	2.3	**5.4**	0.1
Menetus	0.7	1.1	0.8	2.2	**5.0**	0.4
Chaoborus	0.2	1.7	1.9	2.1	**4.1**	0
Dicrotendipes	1.9	1.8	2.8	2.6	0.5	**6.3**
Caenis latipennis	4.1	1.1	2.9	4.0	1.5	**5.1**

Table 9
North Fork of the Spring River Test Station Samples and Horse/Cedar Creek Reference Station Samples, Mean (SD) Values for Macroinvertebrate Community Composition, Fall Data

Variable-Station	Horse/Cedar Creeks	North Fork of the Spring River
Sample Size (n)	5	5
Taxa Richness	78.4 (12.9)	70.0 (10.7)
Number EPT Taxa	14.4 (2.3)	6.6 (2.4)
% EPT	28.9 (9.1)	8.8 (8.0)
% Ephemeroptera	19.7 (8.7)	8.0 (6.9)
% Plecoptera	0.0 (0.0)	0.0 (0.0)
% Trichoptera	9.1 (9.6)	0.8 (1.1)
% Dominant Macroinvertebrate Families		
Chironomidae	32.8 (9.4)	33.1 (12.7)
Elmidae	10.4 (6.9)	20.1 (8.7)
Caenidae	8.5 (9.8)	2.7 (1.4)
Hyalellidae	8.5 (3.5)	5.8 (4.7)
Hydropsychiidae	6.7 (8.7)	0.4 (0.9)
Heptageniidae	6.0 (3.0)	1.1 (0.2)
Tubificidae	5.4 (2.7)	11.7 (3.8)
Coenagrionidae	2.9 (1.4)	2.1 (1.4)
Baetidae	1.6 (0.9)	2.9 (6.1)
Corbiculidae	1.6 (3.4)	0.1 (0.3)
Planorbidae	1.5 (1.1)	2.3 (2.2)
Sphaeriidae	0.9 (0.9)	3.7 (1.4)
Scirtidae	0.6 (0.4)	1.6 (1.6)

Table 10
North Fork of the Spring River Test Stations, Coon Creek Control Station, and Cedar Creek Reference Station, Macroinvertebrate Family Composition per Station, Spring 2004

Variable-Station	N. Fk. Spring River #1	N. Fk. Spring River #2	N. Fk. Spring River #3	N. Fk. Spring River #4a	N. Fk. Spring River #4b	N. Fk. Spring River #5	Coon Creek #1	Cedar Creek #1
Macro Sample Number	04-18702	04-18703	04-18704	04-18705	04-18706	04-18707	04-18708	04-18696
Taxa Richness	63	78	76	79	77	70	54	84
Number EPT Taxa	7	11	8	9	9	10	7	18
% Ephemeroptera	5.5	4.1	7.8	1.6	1.8	3.1	1.3	12.8
% Plecoptera	0.2	1.2	0.2	2.9	2.9	4.4	6.0	4.3
% Trichoptera	0.2	0.7	0.9	0.6	0.5	0.2	0.9	3.5
% Dominant Macroinvertebrate Families								
Tubificidae	**29.1**	**22.1**	**16.2**	**20.0**	**15.2**	**10.9**	**5.1**	**6.1**
Chironomidae	**22.8**	**48.7**	**45.3**	**42.5**	**42.7**	**44.3**	**33.9**	**38.1**
Simuliidae	**21.3**	**5.6**	**8.6**	**5.2**	**8.7**	1.5	**7.8**	2.0
Caenidae	**5.4**	3.3	**7.7**	1.3	0.7	2.5	0.6	**6.4**
Asellidae	**5.1**	**4.1**	0.6	**2.9**	0.9	**11.8**	**31.1**	3.2
Elmidae	1.6	**6.2**	**8.6**	**9.1**	**12.0**	**7.2**	1.3	**12.9**
Sphaeriidae	3.7	1.1	1.2	1.6	**3.2**	1.1	0.2	1.5
Dytiscidae	0.2	0.8	1.1	1.6	1.5	**3.7**	2.3	1.6
Perlidae	0.2	1.2	0.1	2.5	2.5	3.5	**5.5**	3.8
Hyalellidae	1.1	0.7	0.3	1.5	1.9	3.1	0	**8.1**

Table 11
North Fork of the Spring River Test Stations, Coon Creek Control Station, and Cedar Creek Reference Station, Macroinvertebrate Taxa Composition per Station, Spring 2004

Variable-Station	N. Fk. Spring River #1	N. Fk. Spring River #2	N. Fk. Spring River #3	N. Fk. Spring River #4a	N. Fk. Spring River #4b	N. Fk. Spring River #5	Coon Creek #1	Cedar Creek #1
Macro Sample Number	04-18702	04-18703	04-18704	04-18705	04-18706	04-18707	04-18708	04-18696
% Dominant Macroinvertebrate Taxa								
Immature Tubificidae	**23.5**	**13.4**	**11.1**	**14.5**	**11.1**	**7.9**	4.1	4.6
Limnodrilus hoffmeisteri	**5.2**	**8.00**	2.1	4.0	3.7	2.1	0.9	1.3
Simulium	**21.3**	5.6	**8.6**	**5.2**	**8.7**	1.5	**7.7**	2.1
Cricotopus/Orthocladius	**7.9**	**16.6**	**11.8**	**12.8**	**18.9**	**16.5**	**19.3**	**7.1**
Hydrobaenus	0.9	**5.8**	7.2	4.9	**6.9**	**9.1**	**6.5**	3.1
Eukiefferiella	0.5	3.0	6.0	**12.1**	5.2	**10.7**	4.1	3.1
Polypedilum convictum grp.	1.3	2.6	2.3	1.0	1.9	0.4	0	**12.1**
Stenelmis	1.4	**5.8**	**8.0**	**8.8**	**11.5**	7.1	1.2	**12.9**
Lirceus	5.1	4.1	0.6	2.9	0.8	**11.8**	**30.7**	3.0
Hyalella azteca	1.1	0.7	0.3	1.5	1.9	3.1	0	**8.16**
Caenis latipennis	**5.4**	3.3	**7.7**	1.3	0.7	1.2	0.6	**6.4**
Perlesta	0.1	1.2	0.1	2.5	2.5	3.5	**5.5**	3.9

Table 12
North Fork of the Spring River Test Station Samples and Horse/Cedar Creek Reference Station Samples, Mean (SD) Values for Macroinvertebrate Community Composition, Spring Data

Variable-Station	Horse/Cedar Creeks	North Fork of the Spring River
Sample Size (n)	5	6
Taxa Richness	76.6 (7.5)	73.8 (6.2)
Number EPT Taxa	18.0 (1.2)	9.0 (1.4)
% EPT	23.9 (5.8)	6.4 (1.5)
% Ephemeroptera	11.9 (4.3	4.0 (2.4)
% Plecoptera	10.1 (6.8)	2.0 (1.7)
% Trichoptera	1.9(1.1)	0.5 (0.3)
% Dominant Macroinvertebrate Families		
Chironomidae	39.7 (5.0)	41.0 (9.2)
Tubificidae	9.9 (3.3)	18.9 (6.3)
Caenidae	7.0 (4.8)	3.5 (2.6)
Hyalellidae	6.7(5.0)	1.4 (1.0)
Elmidae	5.6(4.5	7.4 (3.5)
Perlidae	5.1 (3.6)	1.7 (1.4)
Perlodidae	4.4 (3.9)	0.1 (0.1)
Simuliidae	3.6(3.3)	8.5 (6.8)
Asellidae	1.0 (1.3)	4.2 (4.1)
Sphaeriidae	0.4 (0.6)	2.0 (1.2)
Dytiscidae	0.8 (0.8)	0.5 (1.2)

3.2.4 Detrended Correspondence Analysis

Detrended Correspondence Analysis (DCA) was conducted using non-flow (NF) and rootmat (RM) habitat data from biocriteria reference stations from Cedar, Horse, and Little Drywood Creeks, and from test stations in the North Fork of the Spring River watershed (Figure 2). This ordination analysis was done to determine if North Fork of the Spring River has a biological community closer to a plains stream or closer to a transitional Ozark stream. Biological data collected from NF and RM were the only sampling habitats in common in this analysis since plains streams are sampled as glide/pool streams and Ozark streams are sampled as riffle/pool streams (**SMSBPP**) (2003b). Axis 1 of Detrended Correspondence Analysis (DCA) showed that the North Fork of the Spring River test stations, except for a few exceptions, had a biological community more like Little Drywood Creek than Horse and Cedar Creeks (Figure 2). The one exception during the fall sampling season was Cedar Creek sample #03-18696, which ordinated

on axis 1 very close to the North Fork of the Spring River test stations. The other exception was that two Little Drywood Creek samples (#01-19546 and #01-19547) during the spring sampling season ordinated on axis 1 closer to Horse and Cedar Creeks than the other Little Drywood Creek samples and the test stations in the North Fork of the Spring River watershed.

Spearman Rank correlation was conducted between Detrended Correspondence Analysis (DCA) axis 1 and macroinvertebrate taxonomic groups to determine differences between the transitional reference streams (Horse and Cedar Creeks), Little Drywood Creek, and test stations in the North Fork of the Spring River watershed (Table 13). Fall macroinvertebrate data, except for Cedar Creek sample #03-19696, showed that EPT taxa, percent EPT, Trichoptera, Leptoceridae, *Ablabesmyia*, and *Enallagma* were significantly higher at Horse and Cedar Creeks while Oligochaeta, *Chironomus*, *Chaoborus*, *Physella*, and *Lirceus* were significantly higher at Little Drywood Creek and North Fork of the Spring River. Taxa richness and taxonomic groups such as Ephemeroptera and *Hyalella azteca* were also higher, but not significant, at Horse and Cedar Creeks during the fall sampling season. Spring data, except for Little Drywood Creek samples #01-19546 and #01-19547, showed that Chironomidae, *Hydrobaenus*, and *Hyalella azteca* were significantly higher at Horse and Cedar Creeks while Oligochaeta, *Simulium*, and *Lirceus* were significantly higher at Little Drywood Creek and test stations in the North Fork of the Spring River watershed.

Figure 2

Detrended Correspondence Analysis (DCA) of Axes 1 and 2 of Non-Flow (NF) and Root Mat (RM) Data for the Fall (Top) and Spring (Bottom) Sampling Seasons from Reference Stations From Horse, Cedar, and Little Drywood Creeks and From Test Stations in the North Fork of the Spring River Watershed.

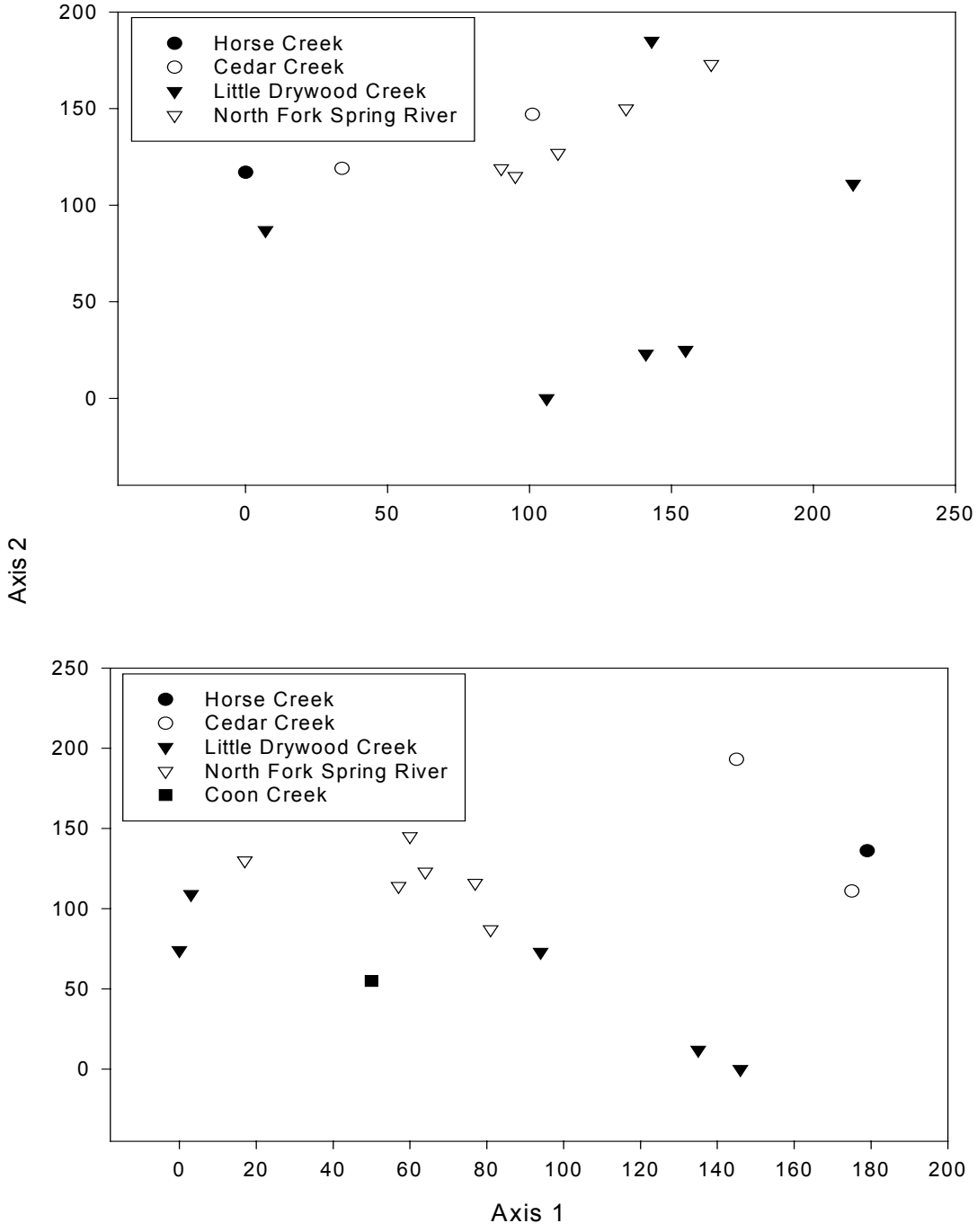

Table 13
Two-tailed Spearman Rank Correlation Coefficient (*p* Value) Values Between DCA Axis 1 and Macroinvertebrate Taxonomic Groups for Fall and Spring Sampling Seasons. Values in Bold are Significant at $p < 0.05$.

	DCA Axis 1 (Fall)	**DCA Axis 1 (Spring)**
Taxa Richness	-0.52 (0.06)	-0.23 (0.40)
EPT Taxa	**-0.72 (0.00)**	0.25 (0.35)
Percent Macroinvertebrate Taxonomic Groups		
EPT	**-0.56 (0.04)**	-0.06 (0.82)
Ephemeroptera	0.49 (0.07)	-0.13 (0.64)
Plecoptera	-	-0.15 (0.58)
Trichoptera	**-0.87 (0.00)**	0.22 (0.42)
Oligochaeta	**0.72 (0.00)**	**-0.63 (0.01)**
Chironomidae	0.03 (0.90)	**0.60 (0.02)**
Ablabesmyia	**-0.59 (0.02)**	0.33 (0.22)
Chironomus	**0.70 (0.01)**	-0.40 (0.13)
Hydrobaenus	-	**0.69 (0.00)**
Chaoborus	**0.66 (0.01)**	-0.11 (0.70)
Simulium	**-**	**-0.72 (0.00)**
Physella	**0.60 (0.02)**	0.16 (056)
Leptoceridae	**-0.87 (0.00)**	0.08 (0.77)
Hyalella azteca	-0.51 (0.06)	**0.72 (0.00)**
Lirceus	**0.53 (0.05)**	**-0.59 (0.02)**
Enallagma	**-0.54 (0.04)**	**0.52 (0.05)**

3.2.5 Physicochemical Water

Physicochemical results are arranged to demonstrate trends of certain variables that may identify a source for impacts to the North Fork of the Spring River. Results can be found in Table 14 for fall 2003 samples and in Table 15 for spring 2004 samples. No results were listed in this section for variables that were either not outstanding or non-detectable. Results shown here are for quality control, discharge, turbidity, ammonia-N, nitrate + nitrite-N, TKN, total phosphorus, and dissolved oxygen by season.

3.2.5.1 Quality Control

North Fork of the Spring River #3a and #3b of spring 2003 samples (Table 14) and North Fork of the Spring River #4a and #4b of fall 2004 samples (Table 15) were duplicate water quality samples. Results from these duplicates were similar and indicated that sampling, transport, processing, and analyses of samples were consistent as well as precise.

3.2.5.2 Discharge

Discharge during the fall 2003 sample season was low except at sample station #4 which was still high from a rain event that occurred on September 21, 2003 (Table 14). It ranged from 0.04 cfs at North Fork of the Spring River #2 to 6.01 cfs at North Fork of the Spring River #4.

Discharge was much higher during the spring 2004 sample season (Table 15). It ranged from 36.6 cfs at North Fork of the Spring River #5 to 87.5 cfs at North Fork of the Spring River #1.

3.2.5.3 Turbidity

Turbidity was much higher at North Fork of the Spring River #1 than the other test stations for both the fall 2003 and spring 2004 sampling seasons (Tables 14 and 15). All of the North Fork of the Spring River test stations and the Coon Creek station (spring 2004 sampling season only) had higher turbidity values than the Cedar Creek reference station for both sampling seasons.

3.2.5.4 Nutrients

Nutrient parameters were elevated at the North Fork of the Spring River #4 during the fall 2003 sampling season. The nutrient parameters that were elevated were ammonia-N, nitrate + nitrite-N, TKN, and total phosphorous.

Nitrate + nitrite-N, TKN, and total phosphorous were elevated at all of the North Fork of the Spring River test stations and the Coon Creek station compared to the Cedar Creek reference station during the spring 2004 sampling season.

3.2.5.4.1 Ammonia-N

Ammonia-N was 3.56 mg/L (4.27 mg/L when converted to total ammonia) at North Fork of the Spring River #4 during the fall 2003 sampling season (Table 14). This value was higher than the chronic value (2.2 mg/L) for total ammonia in the Water Quality Standards for the General Warm Water Fishery (GWWF) classification (MDNR 2000). Ammonia-N values at the other sample stations were well below Water Quality Standards.

Ammonia-N was not elevated at any of the sampling stations during the spring 2004 sampling season, ranging from 0.03 to 0.15 mg/L (Table 15).

3.2.5.4.2 Nitrate + Nitrite-N

Nitrate + nitrite-N had an elevated value of 3.06 mg/L at North Fork of the Spring River #4 during the fall 2003 sampling season (Table 14). This value was much higher than other sample stations and normal reference conditions for nitrate + nitrite-N, even though there are no water quality standards for nitrate + nitrite-N in the Missouri Water Quality Standards (MDNR 2000) for the protection of aquatic life designation. The only water quality standard for nitrate + nitrite-N is 10.0 mg/L for the drinking water supply designation. Nitrate + nitrite-N ranged from 0.07 to 0.26 at the other test stations.

Nitrate + nitrite-N was elevated during the spring 2004 sampling season at all of the North Fork of the Spring River test stations and the Coon Creek station compared to the Cedar Creek reference station (Table 15). Nitrate + nitrite-N ranged from 1.28 mg/L at North Fork of the Spring River #1 to 2.25 mg/L at North Fork of the Spring River #5.

3.2.5.4.3 TKN

TKN was 6.57 mg/L at North Fork of the Spring River #4 during the fall 2003 sampling season (Table 14). This value was much higher than TKN values at the other sample stations with values ranging from 1.03 mg/L to 1.08 mg/L. The TKN values for all of the North Fork of the Spring River stations were much higher than the TKN value at the Cedar Creek reference station.

TKN was not extremely high at any of the sampling stations during the spring 2004 sampling season, but the values at the North Fork of the Spring River test stations and the Coon Creek station were much higher than the value at the Cedar Creek reference station (Table 15).

3.2.5.4.4 Total Phosphorus

Total phosphorus had an elevated value of 1.51 mg/L at North Fork of the Spring River #4 during the fall 2003 sampling season (Table 14). This value was much higher than other sample stations and normal reference conditions for total phosphorus, even though there are no water quality standards for total phosphorus in the Missouri Water Quality Standards (MDNR 2000). Total phosphorus ranged from 0.16 to 0.19 mg/L at the other sample stations.

Total phosphorus was not extremely high at any of the sampling stations during the spring 2004 sampling season, but the values at the North Fork of the Spring River test stations and the Coon Creek station were higher than the value at the Cedar Creek reference station (Table 15).

3.2.5.5 Dissolved Oxygen

Dissolved oxygen was consistently low at all of the test stations except North Fork of the Spring River #4 which had a higher discharge than the other sample stations during the fall 2003 sampling season (Table 14). The higher discharge at sample station #4 was from recent rains in the area. Dissolved oxygen ranged from 5.10 to 5.30 mg/L at sample stations #1-#3 which were slightly higher than the 5.0 mg/L minimum value found in the Missouri Water Quality Standards (MDNR 2000) for the protection of aquatic life designation.

Dissolved oxygen was not low at any of the sampling stations during the spring 2004 sampling season (Table 15). Dissolved oxygen at the North Fork of the Spring River test stations ranged from 9.58 mg/L at station #1 to 10.30 mg/L at stations #2 and #3.

Table 14
Physicochemical Variables for the North Fork of the Spring River Study in Fall 2003
Units mg/L Unless Otherwise Noted.

Variable-Station	N. Fk. Spring River #1, Test Fall 2003	N. Fk. Spring River #2, Test Fall 2003	N. Fk. Spring River #3a, Test Fall 2003	N. Fk. Spring River #3b, Test Fall 2003	N. Fk. Spring River #4, Test Fall 2003	Cedar Creek #1, Reference Fall 2003
Sample Number	03-00817	03-00818	03-00819	03-00820	03-00821	03-00822
Sample Date	09/23/2003	09/23/2003	09/22/2003	09/22/2003	09/22/2003	09/23/2003
Sample Time	1255	1040	1600	1610	1215	1530
pH (Units)	7.50	7.30	7.81	7.81	7.61	7.80
Temperature (C^0)	18.0	16.5	19.0	19.0	19.0	19.5
Conductivity (uS)	236	303	339	340	443	404
Dissolved O_2	5.30	5.20	5.25	5.10	7.60	9.10
Discharge (cfs)	0.12	0.04	0.17	0.17	6.01	4.39
Turbidity (NTUs)	**48.8**	15.4	19.3	21.1	16.4	5.82
Ammonia-N	0.11	0.03	0.03	0.03	**3.56**	0.03
Nitrate/Nitrite-N	0.26	0.07	0.20	0.20	**3.06**	0.62
TKN	1.03	1.08	1.07	1.05	**6.57**	0.35
Chloride	10.6	19.6	21.5	21.7	28.2	10.5
Total Phosphorus	0.19	0.18	0.17	0.16	**1.51**	0.08

Table 15
Physicochemical Variables for the North Fork of the Spring River Study in Spring 2004
Units mg/L unless otherwise noted.

Variable-Station	N. Fk. Spring River #1, Test Spring 2004	N. Fk. Spring River #2, Test Spring 2004	N. Fk. Spring River #3, Test Spring 2004	N. Fk. Spring River #4a, Test Spring 2004	N. Fk. Spring River #4b, Test Spring 2004	N. Fk. Spring River #5, Test Spring 2004	Coon Creek #1, Test Spring 2004	Cedar Creek #1, Reference Spring 2004
Sample Number	04-11054	04-11055	04-11056	04-11057	04-11058	04-11059	04-11060	04-11061
Sample Date	04/01/2004	04/01/2004	04/01/2004	03/31/2004	03/31/2004	03/31/2004	03/31/2004	03/18/2004
Sample Time	1110	1330	1545	1130	1140	1520	0850	0925
pH (Units)	6.87	7.24	7.23	7.57	7.22	7.86	6.69	7.66
Temperature (C^0)	12.0	12.5	13.0	10.5	11.0	12.1	9.5	9.0
Conductivity (uS)	250	273	288	273	272	258	290	373
Dissolved O_2	9.58	10.30	10.30	9.59	9.73	10.10	10.10	12.00
Discharge (cfs)	87.5	60.6	49.1	47.1	47.1	36.6	53.1	43.9
Turbidity (NTUs)	**55.6**	25.4	23.0	27.7	26.0	22.5	20.1	5.91
Ammonia-N	0.15	0.03	0.03	0.03	0.05	0.03	0.03	0.03
Nitrate/Nitrite-N	**1.28**	**1.84**	**2.13**	**2.23**	**2.23**	**2.25**	**1.66**	0.77
TKN	1.30	0.80	0.65	0.86	0.88	0.78	0.50	0.15
Chloride	14.7	16.6	18.5	17.3	16.7	16.8	11.6	10.0
Total Phosphorus	0.29	0.20	0.19	0.24	0.24	0.21	0.14	0.02

4.0 Discussion

The discussion describes possible effects of stream habitat and physicochemical conditions on the biological metric scores and the macroinvertebrate community composition.

4.1 Habitat Assessment

Results of the stream habitat assessment during the spring 2004 sampling season are based on total habitat scores which suggest that the test stations should be comparable to the control station in their ability to support a similar quality macroinvertebrate community. But some habitat categories of the SHAPP such as epifaunal substrate and riffle quality indicated that the North Fork of the Spring River should not have a comparable macroinvertebrate community for coarse substrate (CS) habitat in riffle/run areas compared to reference quality streams. Another characteristic of the North Fork of the Spring River test stations that might limit the macroinvertebrate community was that riffles were very short in length making a very small percentage of the sample reach while pools were very long. The lack of good substrate in riffles also provides a potential reason why the North Fork of the Spring River SCI values generally scored poorer when compared to the macroinvertebrate community from Horse and Cedar Creek reference stations during the fall sampling season.

Other habitat categories of the SHAPP, except for bank vegetative cover, did not indicate that sediment was or would be a problem in the future. Embeddedness and percent of stream bottom covered with fine sediment were generally low at the North Fork of the Spring River test stations. The two downstream stations of North Fork of the Spring River did have more fine sediment than the three upstream stations with about 25 percent of the sample reach covered with fine sediment at North Fork of the Spring River #1. North Fork of the Spring River #1 is the part of the stream that turns into a prairie-type (glide/pool) stream. Turbidity values for North Fork of the Spring River #1 were also much higher for both sample seasons compared to the other test stations (Tables 14 and 15) which indicates that suspended sediment might be higher at that station. Other habitat categories such as bank condition and riparian condition were generally in good condition and did not seem to be a major cause of sedimentation in the river system. The only habitat category that indicated that sediment has or could be a problem in North Fork of the Spring River was bank vegetative protection. There was little bank vegetation at all of the North Fork of the Spring River test stations.

4.2 Possible Effects of Land Use on the Macroinvertebrate Community and Sedimentation

Row crops make up a much larger percentage and forest cover makes up a much smaller percentage of the land use of the North Fork of the Spring River watershed than the entire Ozark/Elk/Spring EDU, Horse Creek, and Cedar Creek (Table 2). North Fork of the Spring River had land use characteristics more like Little Drywood Creek, a reference stream for the Osage/Plains EDU, than Horse and Cedar Creeks. There is also a trend of increasing row crop production moving in a downstream direction in the North Fork of the Spring River watershed with more row crops near test station #1 than test station #5. The Coon Creek watershed had

even more row crop production than any North Fork of the Spring River test stations. A higher percentage of row crops and lower percentage of forest cover in the North Fork of the Spring River watershed could lead to increased runoff that might cause the stream to be more hydrologically flashy. This would result in less rainfall infiltrating into the ground and more entering the stream as surface runoff. The increased runoff could carry more contaminants, such as fertilizer and pesticides, from the farm fields and could lead to water quality problems that could affect the biotic community.

In order to test the potential differences, sediment load was calculated using the Spreadsheet Tool for the Estimation of Pollutant Load (STEPL), version 2.01, which was developed for the United States Environmental Protection Agency by Tetra Tech, Inc. in May 2002. Sediment loads in North Fork of the Spring River ranged from 0.15 to 0.18 tons/acre/year and were similar to sediment loads at Horse and Cedar Creeks (Table 16). Estimated sediment load at Little Drywood Creek had higher values and ranged from 0.26 to 0.36 tons/acre/year. These values indicate that potential erosion from farm fields may not be a major source of sediment in the upper North Fork of the Spring River watershed since it had similar sediment load values when compared to Horse and Cedar Creeks.

Table 16
STEPL Model Sediment Loss Estimations (tons/acre/year) for Horse Creek, Cedar Creek, North Fork of the Spring River, Coon Creek, and Little Drywood Creek

Sample Station	Acres Urban	Acres Crop	Acres Pasture	Acres Forest	Total Acres	Soil Loss (Tons per Acre per Year)
Horse Creek #1	249.74	13269.12	75648.63	30720.07	120588.80	0.16
Horse Creek #2	249.74	12378.45	70651.52	28150.79	112099.84	0.16
Cedar Creek #1	0	2369.12	38023.12	9812.74	50310.40	0.18
Cedar Creek #2	0	2280.61	33243.97	7239.23	42854.40	0.19
NF Spring River #1	177.91	11009.19	56554.89	6045.67	74272.00	0.15
NF Spring River #2	156.12	7598.40	45628.42	3533.33	57152.00	0.15
NF Spring River #3	156.12	5996.30	39181.11	2419.38	48019.00	0.16
NF Spring River #4	11.34	3434.37	23583.57	1703.29	28893.00	0.18
NF Spring River #5	0	3367.87	23073.63	1569.41	28166.40	0.18
Coon Creek #1	0	3280.92	20906.66	2432.95	26668.80	0.21
Little Drywood Creek #1	23.13	10602.89	38905.13	13829.54	63865.60	0.26
Little Drywood Creek #2	0	5551.97	18600.70	7376.01	31923.00	0.32
Little Drywood Creek #3	0	2984.25	10773.46	4408.66	18291.20	0.36

4.3 Transitional Nature of North Fork of the Spring River

North Fork of the Spring River is a transitional stream and has characteristics of both Ozark and plains streams. Detrended Correspondence Analysis (DCA) was conducted using non-flow (NF) and rootmat (RM) from biocriteria reference stations from Cedar, Horse, and Little Drywood Creeks and from test stations in the North Fork of the Spring River watershed (Figure 2). Axis 1 of Detrended Correspondence Analysis (DCA) showed that the North Fork of the Spring River test stations, except for a few exceptions, had a biological community more similar to Little Drywood Creek than Horse and Cedar Creeks (Figure 2).

Macroinvertebrate taxa with high biotic index values and tolerant of low dissolved oxygen levels such as Oligochaeta, *Chironomus*, *Chaoborus,* and *Physella* were more abundant, especially during the fall sampling season, in Little Drywood Creek and North Fork of the Spring River (Table 13). *Enallagma* and *Hyalella azteca* were the only taxa with high biotic index values that were abundant in Horse and Cedar Creeks during the fall sampling season. EPT taxa and percent EPT were also higher at Horse and Cedar Creeks during the fall sampling season. These results along with water quality data indicate that North Fork of the Spring River and Little Drywood Creek have macroinvertebrate communities that are more tolerant of low dissolved oxygen. Some of the taxa with high biotic index values such as Oligochaeta and *Chironomus* might also be good indicators of sedimentation. EPT taxa at North Fork of the Spring River test stations during the spring sampling season were generally lower than transitional reference streams (Horse and Cedar Creeks) and Little Drywood Creek. The result explains why there was no good correlation to axis 1 of Detrended Correlation Analysis (DCA) for EPT, percent EPT, percent Ephemeroptera, percent Plecoptera, and percent Trichoptera.

4.4 Water Quality and Water Quantity Impacts

North Fork of the Spring River #4 had elevated levels of ammonia-N, nitrate + nitrite-N, TKN, and total phosphorus during the fall sampling season (Table 14). The ammonia-N value of 3.56 mg/L was a chronic violation of the water quality standards. Water quality may have impacted the macroinvertebrate community at test station #4 since it showed impairment with a SCI score of 10, the lowest score for all of the North Fork of the Spring River stations for the fall sampling season (Table 6). Taxa richness and the Shannon Diversity Index were much lower and EPT taxa was slightly lower than the other test stations on North Fork of the Spring River. None of the other test stations had elevated levels for nutrients even though they generally had lower SCI scores, except station #1. Nitrate + nitrite-N was elevated at North Fork of the Spring River and Coon Creek test stations during the spring 2004 sampling season compared to Cedar Creek (Table 15). This indicates that surface runoff could be a problem in the watershed during the spring planting season when fertilizer is usually applied. All of the test stations in the North Fork of the Spring River watershed had low SCI scores (Table 7), even though there is no direct evidence that elevated levels of nutrients impacted the macroinvertebrate community.

Turbidity is another water quality parameter that was elevated and could indicate a sedimentation problem that may impact the macroinvertebrate community. Turbidity was elevated at all of the

test stations for both sampling seasons compared to the Cedar Creek reference station (Tables 14 and 15). Turbidity was much higher at test station #1 than the other test stations, which is just upstream where the North Fork of the Spring River seems to lose it's transitional qualities and changes to a prairie-type stream.

In the Missouri Department of Natural Resources Water Quality Standards, the North Fork of the Spring River is listed as a class "C" stream. A class "C" stream may cease flow, may dry up at riffle/run areas, and pools may become isolated during the low flow summer period. All of the North Fork of the Spring River test stations, except station #1, had ceased flow and were pooled during a site recon on August 12, 2003. Flow had resumed at all of the sites by the time fall samples were collected on September 22 and 23, 2003. Flow was very low at all of the stations, except station #4, during the fall 2003 sampling season. The low flow at the sites decreased the coarse substrate area that could be sampled and made it difficult to sample. The low flow conditions during sampling and the lack of flow during the previous month may have reduced the taxa in the coarse substrate habitat to those that are tolerant to these conditions. The intermittent condition of North Fork of the Spring River may be one of the possible reasons, along with substrate quality and poor water quality, for low SCI scores compared to Horse and Cedar Creeks. North Fork of the Spring River generally had lower numbers of EPT taxa that are more commonly found in good coarse substrate and had a higher abundance of taxa such as tubificid worms that are more tolerant of poorer conditions than Horse and Cedar Creeks (Tables 9 and 12).

5.0 Conclusions

SCI scores from the upper North Fork of the Spring River indicate that the macroinvertebrate community is impaired compared to Horse and Cedar Creeks. North Fork of the Spring River had a higher abundance of tolerant taxa such as tubificid worms and a lower abundance of intolerant EPT taxa. All of the test stations for both sample seasons scored in the partially sustainable category, except North Fork of the Spring River #1 during the fall sampling season, which scored in the fully sustainable category (Tables 6 and 7). The first null hypothesis that all of the test stations would have a similar macroinvertebrate community was accepted, except for station #1 during the fall sampling season. The second null hypothesis that North Fork of the Spring River test stations would not differ from the two transitional streams (Horse and Cedar Creeks) was rejected.

Detrended Correspondence Analysis (DCA), on the other hand, indicates that the macroinvertebrate community in North Fork of the Spring River is more like Little Drywood Creek, a biocriteria reference stream in the Osage/Plains, than Horse and Cedar Creeks (Figure 1 and Table 13). Since North Fork of the Spring River is a transition stream, more sampling may be needed to compare it to Little Dywood Creek and the two transitional reference streams (Horse and Cedar Creeks). All four habitats (CS, NF, RM, and snag [SG]) at the North Fork of the Spring River test stations would need to be collected to make comparisons of both stream types (glide/pool and riffle/pool). A quantitative leaf pack study is currently being conducted on

the lower North Fork of the Spring River with two control stations on Flat Rock Creek, a tributary of the Neosho River in Eastern Kansas and one reference/control station on Little Drywood Creek, located within the biocriteria reference reach. This study may help determine if the macroinvertebrate community in North Fork of the Spring River is more like a prairie stream than an Ozark transitional stream.

The overall habitat assessment scores indicate that North Fork of the Spring River should support a similar macroinvertebrate community compared to the two transitional streams even though some habitat variables important to macroinvertebrates scored poorly. Epifaunal substrate and riffle quality at the North Fork of the Spring River test stations scored either in the poor or marginal range. The poor coarse substrate in North Fork of the Spring River may limit the number of taxa that can live in this stream. Other habitat variables, except for bank vegetative cover, did not indicate that sedimentation was a major cause of impairment. Embeddedness was low and sediment deposition was in the optimal or suboptimal category of the habitat assessment. Other categories such as riparian zone and bank stability were also generally good. The category that may indicate past or future problems was bank vegetation cover. The banks generally had low vegetation and were bare.

The land use in the North Fork of the Spring River watershed had a higher percentage of land in row crops than the watersheds of Horse and Cedar Creeks and is more comparable to Little Drywood Creek (Table 2). Row crops made up 12.4 to 21.4 percent of the North Fork of the Spring River watershed. Estimated sediment load indicated that North Fork of the Spring River was more similar to the two transition streams (Horse and Cedar Creeks) and was much lower than the estimated sediment load for Little Drywood Creek (Table 16). The high percentage of agriculture production in the watershed and water quality data collected during this study indicates that surface runoff may be a problem in the watershed. During the fall sampling season, North Fork of the Spring River #4 was collected approximately a day after a rain event and had high levels of ammonia-N, nitrate + nitrite-N, TKN, and total phosphorous. All of the test stations in the North Fork of the Spring River watershed had elevated levels of nitrate + nitrite-N compared to the Cedar Creek reference station during the spring 2004 sampling season. Turbidity was also higher at North Fork of the Spring River test stations compared to Cedar Creek with test station #1 being much higher than at the other stations for both sample seasons. Dissolved oxygen was low at the North Fork of the Spring River test stations, except for station #4 during the fall 2003 sampling season.

In conclusion, North Fork of the Spring River was impaired in comparison to the two Ozark transitional streams of Horse and Cedar Creeks. However, analyses by Detrended Correspondence Analysis indicate that North Fork of the Spring River has a macroinvertebrate community that is more similar to Little Drywood Creek, a biocriteria reference stream in the Osage/Plains EDU. Taxa with higher biotic index values, such as Tubificidae and *Chironomus,* were more abundant in North Fork of the Spring River than the two transitional reference streams. This indicates that dissolved oxygen, nutrients, and/or sediment could be a problem in

the watershed. These problems could result from the amount of agriculture land use that occurs in the watershed and this study indicates that nutrient water chemistry levels are a potential problem. The overall SHAPP habitat scores and some habitat variables indicate the stream has comparable habitat conditions to the Ozark transitional reference streams and that benthic sediment deposits were not excessively high. However, sub-optimal epifaunal substrate and the intermittent condition of the stream may play a part in limiting the macroinvertebrate community of North Fork of the Spring River. The results of this study indicate biological impairment of North Fork of the Spring River, but more data is needed before this can be stated conclusively.

6.0 Recommendations

1. Encourage the Missouri Department of Conservation Resource Assessment and Monitoring (RAM) program staff to conduct a fish community study on the North Fork of the Spring River watershed using the fish Index of Biotic Integrity (IBI) and/or other metrics to determine if the fish community indicates impairment like the macroinvertebrate community.

2. Conduct a sediment deposition and/or suspended sediment study on North Fork of the Spring River, Little Drywood Creek, Horse Creek, and Cedar Creek watersheds to determine if sedimentation is a problem in the North Fork of the Spring River watershed. This would involve collecting macroinvertebrates from four habitats (CS, NF, RM, SG) in the North Fork of the Spring River and estimating benthic sediment deposition and/or suspended sediment in the water column.

3. Conduct a water quality study on the entire watershed to determine the impacts of surface runoff on North Fork of the Spring River and its tributaries. This could determine if nutrients or other water quality parameters are elevated after major rainfall events.

7.0 Literature Cited

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Appendix A

Missouri Department of Natural Resources
Bioassessment Study Plan
Upper North Fork of the Spring River
Dade and Barton Counties
August 25, 2003

Missouri Department of Natural Resources
Bioassessment Study Proposal
Upper North Fork Spring River, Barton County
August 25, 2003

Objectives

This study will assess the aquatic macroinvertebrate community in the North Fork Spring River from the Dade and Barton county line near Golden City to the town of Lamar. The North Fork Spring River within the study area is classified by the State of Missouri Water Quality Standards as a class "C" stream and this section has been placed on the 1998 303d list for sediment. The stream originates in Barton and Dade counties near Golden City and flows through a predominately rural area in the Ozark/Elk/Spring Ecological Drainage Unit (EDU). The North Fork Spring River watershed drains a landscape that is transitional in nature between Ozark and plains ecological regions and in the past has been classified as a distinctly different aquatic faunal area than other drainage's in Ozark/Elk Spring EDU (Pflieger, 1989). Since this stream is a transition stream, it will not be compared to streams from the Ozark/Elk/Spring biocriteria database and will instead be compared to two nearby transitional biocriteria streams (Cedar Creek, Cedar County and Horse Creek, Cedar County) in the Ozark/Osage Ecological Drainage Unit (EDU). The objectives of this study are to determine: 1) whether the aquatic macroinvertebrate community is being impacted by excessive amounts of sediment and 2) whether the aquatic macroinvertebrate community of North Fork Spring River is impaired relative to that of two transitional Ozark/Osage biocriteria reference streams.

Null Hypotheses

1) The macroinvertebrate community will not differ between longitudinally separate reaches of North Fork Spring River.

2) The macroinvertebrate community in the North Fork Spring River will not differ from similar sized reaches of two transitional biological criteria reference streams (Cedar Creek, Cedar county and Horse Creek, Cedar county) in the Ozark/Osage Ecological Drainage Unit (EDU).

Background

The North Fork Spring River is a tributary of the Spring River system in southwestern Missouri that flows through a transitional area that has features of both the Ozark and plains ecoregions. It is characterized by long pools with short, rocky and gravelly riffles and the geology of the watershed contains beds of shale, sandstone and limestone (Pflieger, 1989). The goals of the study are to determine if the biological community of this stream is being impaired by excessive amounts of sediment since this section of stream has been placed on 1998 303d list.

Study Design

General: Four North Fork Spring River stations will be surveyed. The general locations are as follows: 1) downstream of SE 60th road (SE1/4, Sec. 23, T31N, R29W); 2) upstream of SE 30th

road (NE1/4, Sec. 9, T31N, R29W; 3) upstream of SE 10th road (NE1/4, Sec. 31, T32N, R29W; and 4) upstream of NE 30th lane (NW1/4, Sec. 16, T32N, R30W). Data from the biocriteria database from Cedar Creek and Horse Creek located in Cedar county, which are transitional biocriteria reference streams from the Ozark/Osage Ecological Drainage Unit (EDU), will be used as references to assess the test stations on the North Fork Spring River. A longitudinal comparison of the North Fork Spring River sampling sites will also be made to try to determine if there are differences in macroinvertebrate community between test sites.

Each station will consist of a length approximately 20 times the average stream width, and will contain at least two riffle areas, as outlined in the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMBPP). To assess comparability between sampling stations, stream discharge, habitat assessment and water chemistry will be determined during the macroinvertebrate surveys. Sampling will be conducted in fall of 2003 (September 15 through October 15) and the spring of 2004 (March 15 through April 15).

Biological Sampling Methods: Macroinvertebrates will be sampled according to the guidelines of the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMBPP). Each of the sampling stations are "riffle/pool" predominant stream reaches; therefore samples will be collected from flow over coarse substrate, depositional (non-flow) and root-mat habitats. If stream sites pool up and have no flow because of low water, coarse substrate habitat will not be sampled. Each macroinvertebrate sample will be a composite of six sub-samples within each habitat.

Habitat Sampling Methods: Stream discharge will be measured at each sampling station with a Marsh-McBirney flow meter according to MDNR-WQMS-113. Stream habitat assessments will also be conducted within each study area according to the guidelines of the Stream Habitat Assessment Project Procedure.

Water Quality Sampling Methods: Water samples from all sampling stations will be analyzed at the ESP laboratory chloride, TKN, ammonia nitrogen, nitrite plus nitrate nitrogen, total phosphorus, and turbidity. Field analyses will include pH, conductivity, temperature and dissolved oxygen.

Laboratory Methods: All macroinvertebrate samples will be processed and identified according to the guidelines of MDNR-WQMS-209. Turbidity samples will be analyzed at the MDNR biological laboratory.

Data Recording and Analyses: Macroinvertebrate data will be entered in a Microsoft Access database according to MDNR-WQMS-214. Data analysis is automated within the Access database. Four standard metrics are calculated according to the SMSBPP: Total Taxa (TT); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Index (SI) will be calculated for each sampling station. Additional metrics, such as Quantitative Similarity Index for Taxa (QSI-T), Percent EPT, or Percent Chironomidae may be employed to discern differences in taxa between test and reference stations.

Macroinvertebrate data will be analyzed in two ways. First, a longitudinal comparison between the four sample reaches of the North Fork Spring River will be made. Secondly, the data from the North Fork Spring River will be compared to data collected from two transitional biocriteria reference streams (Cedar Creek, Cedar county and Horse Creek, Cedar county) in the Ozark/Osage Ecological Drainage Unit (EDU).

Data Reporting: Results of the study will be summarized and interpreted in report format.

Quality Control: As stated in the various MDNR Project Procedures and Standard Operating Procedures.

Literature Cited:

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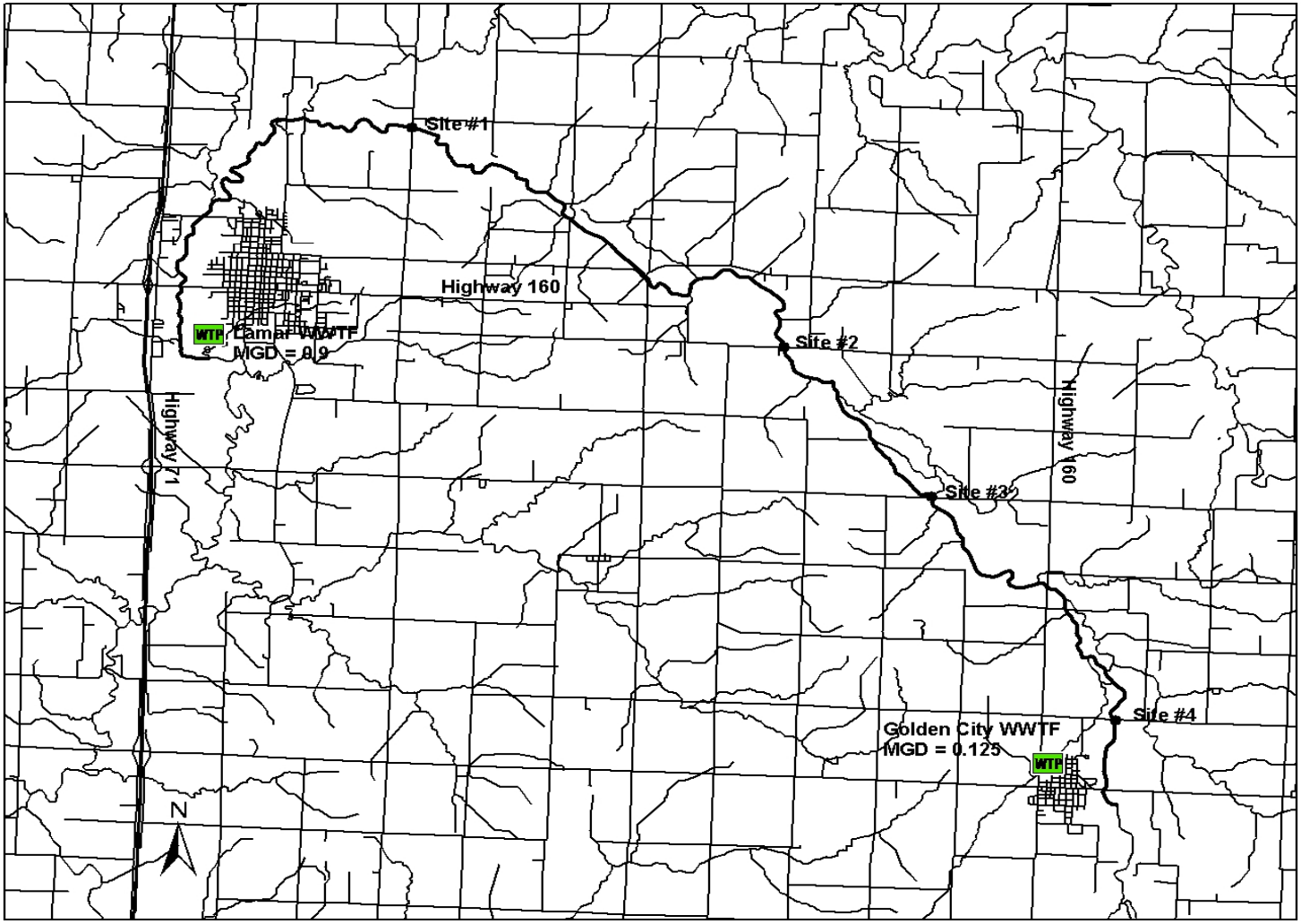
Attachments:

Map of all sampling stations in this study

North Fork of the Spring River Bioassessment Study Sites



Appendix B

Kruskal-Wallis ANOVA on Ranks and Dunn's Multiple Comparison Test Comparing Stream Condition Index (SCI) Values of North Fork of the Spring River Test Stations, Two Transitional Biocriteria Reference Streams (Horse and Cedar Creeks) in the Ozark/Osage EDU, and Other Biocriteria Reference Streams in the Ozark/Osage EDU

Kruskal-Wallis One Way Analysis of Variance on Ranks Friday, October 08, 2004, 08:12:04

Data source: Kruskal-Wallis One Way Analysis of Variance on Ranks comparing Horse/Cedar Creeks, NF Spring River, and other reference streams in the Ozark/Osage EDU

Normality Test: Failed (P = <0.001)

Group	N	Missing	Median	25%	75%
Horse/Cedar Cks	10	0	14.000	14.000	16.000
Other Oz/Osage	35	0	18.000	18.000	20.000
NF Spring River	11	0	10.000	10.000	11.500

H = 37.380 with 2 degrees of freedom. (P = <0.001)

The differences in the median values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001)

To isolate the group or groups that differ from the others use a multiple comparison procedure.

All Pairwise Multiple Comparison Procedures (Dunn's Method):

Comparison	Diff of Ranks	Q	P<0.05
Other Oz/Osage vs NF Spring River	31.351	5.561	Yes
Other Oz/Osage vs Horse/Cedar Cks	19.914	3.405	Yes
Horse/Cedar Cks vs NF Spring River	11.436	1.605	No

Note: The multiple comparisons on ranks do not include an adjustment for ties

.

Appendix C

Upper North Fork of the Spring River Bioassessment Study Macroinvertebrate Bench Sheets

Aquatic Invertebrate Database Bench Sheet Report
September 23, 2003 - North Fk Spring R [0318704], Station #1

ORDER (Taxa)	CS	RM	SG	NF
Branchiobdellida		1		
"HYDRACARINA"				
Acarina	2			11
AMPHIPODA				
Hyalella azteca	1	78		1
ARHYNCHOBDELLIDA				
Erpobdellidae	3	-99		-99
COLEOPTERA				
Dineutus	1			1
Gyrinus	9			
Hydrophilidae	1			
Berosus		1		
Scirtes	7	11		
Dubiraphia		3		6
Stenelmis	84	2		1
DECAPODA				
Orconectes virilis		-99		
DIPTERA				
Chaoborus				3
Forcipomyiinae	1			
Ceratopogoninae				5
Simulium	1			
Ablabesmyia	4	4		9
Larsia	2			
Procladius				55
Cricotopus bicinctus	1			
Corynoneura	4			
Nanocladius		4		
Parakiefferiella		4		
Chironomus				18
Cladopelma				1
Cryptochironomus				3
Dicrotendipes	3	12		11
Glyptotendipes	1	21		1
Cryptotendipes				1
Paralauterborniella				4
Microtendipes	1	1		
Paratendipes	3			
Parachironomus		7		
Microchironomus				1
Polypedilum halterale grp	4			2
Polypedilum convictum grp	102			
Polypedilum illinoense grp	48	3		3
Polypedilum scalaenum grp	7	1		3
Stictochironomus				1
Tribelos	1	3		3
Einfeldia				1
Cladotanytarsus	1			19

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Paratanytarsus		7		
Rheotanytarsus	5			
Tanytarsus	32	13		41
Tabanidae				1
Thienemannimyia grp.	19	5		
Labrundinia	1	2		2
EPHEMEROPTERA				
Acerpenna	167			
Callibaetis		2		
Procloeon				19
Stenacron	7	1		3
Stenonema femoratum	6			
Caenis latipennis	21	4		31
Leptophlebiidae	3	11		
HEMIPTERA				
Corixidae				3
ISOPODA				
Lirceus	9	8		1
LIMNOPHILA				
Lymnaeidae	1			
Physella	1	4		-99
Helisoma				-99
Menetus		9		
Planorbella	1			1
Ancylidae	3	3		
LUMBRICINA				
Lumbricidae		1		
LUMBRICULIDA				
Lumbriculidae	6			6
MEGALOPTERA				
Sialis	2			-99
MESOGASTROPODA				
Hydrobiidae	1	1		3
ODONATA				
Argia	2	18		
Enallagma	1	5		
Nasiaeschna pentacantha	1			
Gomphidae				1
Macromia				-99
Epitheca (Epicordulia)		-99		
Libellula				2
RHYNCHOBDELLIDA				
Glossiphoniidae	1			
TRICHOPTERA				
Cheumatopsyche	27			1
Hydroptila	1			
Oecetis		4		4
TRICLADIDA				
Planariidae	2	2		
TUBIFICIDA				
Tubificidae	68			67

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Limnodrilus hoffmeisteri				1
VENEROIDEA				
Pisidium	4			
Sphaerium	44	3		16
Corbicula	4			4

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

Aquatic Invertebrate Database Bench Sheet Report

September 23, 2003 - North Fk Spring R [0318705], Station #2

ORDER (Taxa)	CS	RM	SG	NF
Branchiobdellida	1	3		1
"HYDRACARINA"				
Acarina		1		1
AMPHIPODA				
Hyalella azteca		16		
ARHYNCHOBDELLIDA				
Erpobdellidae	1			
COLEOPTERA				
Tropisternus		-99		
Helichus lithophilus	1			
Scirtes		48		
Dubiraphia		12		4
Stenelmis	170	3		5
DECAPODA				
Orconectes neglectus	-99	-99		
Orconectes virilis		1		-99
DIPTERA				
Anopheles		1		
Chaoborus				19
Ceratopogoninae	2	1		1
Ablabesmyia	7			3
Procladius	1			23
Corynoneura	1			
Cricotopus/Orthocladius	6			
Parametriocnemus	2			
Thienemanniella	1			
Bryophaenocladius		1		
Chironomus	18	1		69
Cryptochironomus	4			
Dicrotendipes	14	1		5
Glyptotendipes	57	100		34
Cryptotendipes				1
Kiefferulus	46	6		9
Microtendipes	13			
Paratendipes	2			1
Parachironomus	7	7		3
Phaenopsectra	1			
Polypedilum	1			
Polypedilum convictum grp	14			
Polypedilum illinoense grp	49	4		
Polypedilum scalaenum grp	12			
Stictochironomus				1
Tribelos				1
Cladotanytarsus				1
Paratanytarsus	1	1		
Tanytarsus	27	2		13
Tanypus				1
Labrundinia	1			

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
EPHEMEROPTERA				
Acerpenna	2			
Procloeon				2
Stenonema femoratum	9			1
Caenis latipennis	7			5
Leptophlebiidae	1	28		1
HEMIPTERA				
Belostoma		1		
Ranatra		1		
Corixidae	1			3
Mesovelia		3		
ISOPODA				
Lirceus	2	5		
LIMNOPHILA				
Physella	4	10		1
Helisoma		-99		
Menetus		12		
Ancylidae	3	3		2
LUMBRICULIDA				
Lumbriculidae	3	1		2
MEGALOPTERA				
Sialis	6			-99
MESOGASTROPODA				
Hydrobiidae	1			1
NEUROPTERA				
Climacia		1		
ODONATA				
Argia		1		
Enallagma		5		
Libellula		-99		
RHYNCHOBDELLIDA				
Glossiphoniidae		2		1
TRICHOPTERA				
Cheumatopsyche	1			
TRICLADIDA				
Planariidae		8		
TUBIFICIDA				
Tubificidae	38	4		16
Branchiura sowerbyi	9	1		20
Aulodrilus				2
Enchytraeidae		1		
VENEROIDEA				
Sphaerium	29	2		1

Aquatic Invertebrate Database Bench Sheet Report

September 22, 2003 - North Fk Spring R [0318706], Station #3a

ORDER (Taxa)	CS	RM	SG	NF

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

Branchiobdellida		1	
"HYDRACARINA"			
Acarina		8	
AMPHIPODA			
Hyalella azteca		108	
ARHYNCHOBDELLIDA			
Erpobdellidae	3		
COLEOPTERA			
Dineutus		1	
Helichus lithophilus	2		
Scirtes	4	2	
Ancyronyx variegatus		9	
Dubiraphia		40	3
Stenelmis	254	1	1
DECAPODA			
Orconectes neglectus	4		
Orconectes virilis		-99	
DIPTERA			
Chaoborus			24
Forcipomyiinae	7		
Ceratopogoninae		1	2
Ablabesmyia	1	10	
Procladius			45
Corynoneura	2		
Cricotopus/Orthocladius	1		
Nanocladius		1	
Chironomus	4		28
Cladopelma			6
Cryptochironomus	1		
Dicrotendipes	6	28	1
Glyptotendipes	29	45	2
Kiefferulus	2	1	
Microtendipes	20		
Paratendipes	1		1
Parachironomus	14	13	
Polypedilum halterale grp			2
Polypedilum	1		
Polypedilum convictum grp	8		
Polypedilum illinoense grp	57	2	
Polypedilum scalaenum grp	8		
Einfeldia			1
Pseudochironomus			1
Cladotanytarsus			3
Paratanytarsus		2	
Tanytarsus	13	3	18
Hemerodromia	1		
undescribed Empididae	2		
Tanypus			10

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Thienemannimyia grp.	14			
Labrundinia		2		
EPHEMEROPTERA				
Callibaetis		1		
Procloeon				1
Stenacron	7			
Stenonema femoratum	10			
Caenis latipennis	33			4
Leptophlebiidae	5	1		
HEMIPTERA				
Ranatra nigra		-99		
Corixidae				2
ISOPODA				
Lirceus		1		
LIMNOPHILA				
Lymnaeidae		1		
Physella	3	3		
Helisoma		2		1
Menetus	1	9		
Ancylidae	2	7		
LUMBRICULIDA				
Lumbriculidae	4			1
MEGALOPTERA				
Sialis	8			2
MESOGASTROPODA				
Hydrobiidae	1	1		3
NEUROPTERA				
Climacia		1		
ODONATA				
Argia	1	3		
Enallagma		42		
Macromia				1
Libellula				3
RHYNCHOBDELLIDA				
Glossiphoniidae		2		1
TRICHOPTERA				
Triaenodes		2		
Oecetis		5		
TRICLADIDA				
Planariidae	1	1		
TUBIFICIDA				
Tubificidae	79	3		42
Branchiura sowerbyi	3			48
VENEROIDEA				
Sphaeriidae	20	-99		11
Pisidium				1

Aquatic Invertebrate Database Bench Sheet Report

September 22, 2003 - North Fk Spring R [0318707], Station #3b

ORDER (Taxa)	CS	RM	SG	NF

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

"HYDRACARINA"			
Acarina		19	
AMPHIPODA			
Hyalella azteca		128	
ARHYNCHOBDELLIDA			
Erpobdellidae	4		
COLEOPTERA			
Dineutus		-99	
Scirtes	1	2	
Ancyronyx variegatus		-99	
Dubiraphia		42	2
Macronychus glabratus		3	
Stenelmis	185		
DECAPODA			
Orconectes neglectus	5	1	
Orconectes virilis	1	-99	
DIPTERA			
Anopheles		1	1
Chaoborus	22		
Ceratopogoninae			2
Ablabesmyia	1	12	3
Procladius			57
Chironomus	2		26
Cladopelma			10
Dicrotendipes		25	2
Glyptotendipes	7	56	4
Cryptotendipes			2
Kiefferulus		1	
Microtendipes	2		
Paratendipes		1	
Parachironomus	8	4	
Phaenopsectra		1	
Polypedilum halterale grp			1
Polypedilum convictum grp	3		
Polypedilum fallax grp	1		
Stenochironomus	1		
Polypedilum illinoense grp	23	1	
Polypedilum scalaenum grp	2		1
Stictochironomus			2
Cladotanytarsus	1		9
Tanytarsus	5	3	16
Tanypus			9
Thienemannimyia grp.	10		
Natarsia			1
Labrundinia		3	
EPHEMEROPTERA			
Stenacron	3	1	
Stenonema femoratum	6		
Caenis latipennis	36	4	2

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Leptophlebiidae	6	12		
HEMIPTERA				
Corixidae				3
LIMNOPHILA				
Physella	1	4		1
Helisoma		1		
Menetus		23		
Planorbella		2		
Ancylidae	2	5		
LUMBRICULIDA				
Lumbriculidae	5			1
MEGALOPTERA				
Sialis	10			5
MESOGASTROPODA				
Hydrobiidae	1			6
NEUROPTERA				
Climacia		1		
ODONATA				
Argia	1	3		
Enallagma		33		
Gomphus		1		
Macromia		-99		2
Epitheca (Epicordulia)		1		
Libellula		1		
RHYNCHOBDELLIDA				
Glossiphoniidae		5		
TRICHOPTERA				
Oecetis		5		
TRICLADIDA				
Planariidae		2		
TUBIFICIDA				
Tubificidae	50	2		23
Branchiura sowerbyi	2			23
VENEROIDEA				
Pisidium	1			3
Sphaerium	22	2		

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

Aquatic Invertebrate Database Bench Sheet Report
September 22, 2003 - North Fk Spring R [0318708], Station #4

ORDER (Taxa)	CS	RM	SG	NF
Branchiobdellida		6		1
"HYDRACARINA"				
Acarina		13		
AMPHIPODA				
Hyalella azteca		12		
ARHYNCHOBDELLIDA				
Erpobdellidae	10			
COLEOPTERA				
Scirtes	1	16		
Dubiraphia	2	28		5
Stenelmis	316	4		4
DECAPODA				
Orconectes neglectus	-99			1
Orconectes virilis	-99	3		4
DIPTERA				
Chaoborus				49
Psychoda				1
Forcipomyiinae	2			
Ceratopogoninae		1		2
Ablabesmyia	3			
Procladius				10
Chironomus	3	1		25
Dicrotendipes	1	4		1
Glyptotendipes		14		6
Cryptotendipes				1
Kiefferulus	6	14		20
Microtendipes	2			
Paratendipes	5	5		3
Parachironomus	2	16		4
Polypedilum convictum grp	4			
Polypedilum illinoense grp	5	1		4
Polypedilum scalaenum grp	3			
Paratanytarsus	2			
Tanytarsus	13	1		4
Ephydridae				5
Tanypus				1
Labrundinia		1		
EPHEMEROPTERA				
Callibaetis		5		
Stenonema femoratum	3			7
Caenis latipennis	4	7		7
Leptophlebiidae	4	3		
ISOPODA				
Lirceus		2		
LIMNOPHILA				
Lymnaeidae		1		
Physella	16	26		1
Helisoma	-99	2		

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Menetus		59		1
Planorbella	6	1		2
Ancylidae	1	7		29
LUMBRICINA				
Lumbricidae	2			1
LUMBRICULIDA				
Lumbriculidae	8	14		
MEGALOPTERA				
Sialis	7			7
ODONATA				
Argia		8		1
Enallagma		2		
Pachydiplax longipennis		1		
RHYNCHOBDELLIDA				
Glossiphoniidae		1		
TRICLADIDA				
Planariidae		1		
TUBIFICIDA				
Tubificidae	148	2		46
Branchiura sowerbyi				9
Limnodrilus hoffmeisteri	1			1
Enchytraeidae	1			
VENEROIDEA				
Sphaerium	20	37		7

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

September 23, 2003 - Cedar Ck [0318709], Station #1

ORDER (Taxa)	CS	RM	SG	NF
Branchiobdellida	3			1
"HYDRACARINA"				
Acarina		47		2
AMPHIPODA				
Hyalella azteca		46		
ARHYNCHOBDELLIDA				
Erpobdellidae	2	1		-99
COLEOPTERA				
Dineutus		-99		
Hydroporus				1
Berosus		1		
Helichus basalis	1			
Scirtes		3		
Dubiraphia				2
Stenelmis	308	3		1
DECAPODA				
Orconectes neglectus	6			1
Orconectes virilis	-99	-99		2
DIPTERA				
Anopheles		1		
Ceratopogoninae	1	3		13
Simulium	1			
Ablabesmyia	8	1		13
Nilotanypus	1			
Procladius		4		20
Corynoneura	11			2
Cricotopus/Orthocladius	20			
Nanocladius	2	3		
Thienemanniella	2			
Chironomus				56
Cladopelma				3
Cryptochironomus	11	1		2
Dicrotendipes	5	76		13
Glyptotendipes	10	20		4
Cryptotendipes				2
Kiefferulus		1		1
Microtendipes	3			
Paratendipes	5			
Parachironomus	1	14		
Polypedilum	2			
Polypedilum convictum grp	63			
Polypedilum illinoense grp	7	5		
Polypedilum scalaenum grp	2	1		
Stictochironomus				1
Einfeldia		1		5
Cladotanytarsus				1
Paratanytarsus	1	1		
Tanytarsus	36	4		80

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Tabanus	-99			
Clinotanypus		5		1
Tanypus		3		5
Thienemannimyia grp.	6			
Labrundinia		10		
EPHEMEROPTERA				
Acentrella	14			
Acerpenna	6			
Baetis	5			
Callibaetis		4		
Heptageniidae	17			
Leucrocuta	1			
Stenacron	58			2
Stenonema femoratum	9			3
Caenis latipennis	64			12
Leptophlebiidae	21	2		
HEMIPTERA				
Corixidae				2
ISOPODA				
Lirceus	2	1		
LIMNOPHILA				
Physella		1		3
Menetus		4		2
Laevapex	7	1		14
LUMBRICINA				
Lumbricidae	1			
MEGALOPTERA				
Sialis	1			1
Corydalus	1			
ODONATA				
Enallagma		18		1
Gomphus		1		
Libellulidae		1		1
Epitheca (Epicordulia)		-99		
Libellula		4		
RHYNCHOBDELLIDA				
Glossiphoniidae	1			
TRICHOPTERA				
Cheumatopsyche	8			
Hydroptila		2		1
Orthotrichia		1		
Oecetis		1		
TRICLADIDA				
Planariidae	10	12		
TUBIFICIDA				
Tubificidae	50	25		43
Branchiura sowerbyi		2		8
Limnodrilus cervix		1		
Limnodrilus hoffmeisteri		1		
Quistradrilus multisetosus		2		
UNIONIDA				

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Unionidae		-99		
VENEROIDEA				
Sphaeriidae	21	2		7
Pisidium		2		
Corbicula	-99			-99

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

Aquatic Invertebrate Database Bench Sheet Report
March 18, 2004 - Cedar Ck [0418696], Station #1

ORDER (Taxa)	**CS**	**RM**	**SG**	**NF**

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

Gordiidae	1		
"HYDRACARINA"			
Acarina		3	5
AMPHIPODA			
Hyalella azteca	1	103	
Allocrangonyx			1
Crangonyx		2	4
Stygobromus			1
ARHYNCHOBDELLIDA			
Erpobdellidae	1		-99
COLEOPTERA			
Peltodytes		1	
Hydroporus		16	4
Stenelmis	155	3	8
DECAPODA			
Orconectes luteus		1	
Orconectes virilis	-99		
DIPTERA			
Hexatoma	1		1
Ceratopogoninae	1		10
Simulium	25	1	
Ablabesmyia		2	5
Nilotanypus	1		
Procladius			1
Cricotopus bicinctus		5	
Corynoneura		8	7
Cricotopus/Orthocladius	43	20	28
Eukiefferiella	35		4
Nanocladius		1	
Hydrobaenus		10	29
Chironomus			2
Cryptochironomus			7
Dicrotendipes	1		2
Glyptotendipes	1	1	1
Microtendipes			3
Paratendipes	2	2	16
Polypedilum halterale grp			1
Polypedilum convictum grp	151	2	3
Polypedilum fallax grp			1
Polypedilum illinoense grp			2
Polypedilum scalaenum grp	6		4
Stictochironomus			8
Pseudochironomus			4
Cladotanytarsus			7
Micropsectra			1
Paratanytarsus		6	1
Tanytarsus	1	10	41
Tabanus	1		

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Thienemannimyia grp.	4			
Natarsia				1
Labrundinia		1		
EPHEMEROPTERA				
Siphlonurus		3		
Acentrella	28			
Leucrocuta	2			
Stenacron	24			8
Stenonema femoratum	8			3
Caenis latipennis	23	31		28
Leptophlebia		-99		
Paraleptophlebia	1	2		4
ISOPODA				
Lirceus	2	25		12
Caecidotea (Blind & Unpigmented)				2
LIMNOPHILA				
Physella				-99
Menetus		1		1
Ancylidae	6			
LUMBRICINA				
Lumbricidae	3			1
LUMBRICULIDA				
Lumbriculidae	2			1
NEUROPTERA				
Climacia		2		
ODONATA				
Enallagma		5		
Ischnura		-99		
Nasiaeschna pentacantha		-99		
Libellulidae		1		
Epitheca (Epicordulia)		-99		
PLECOPTERA				
Allocapnia	3			
Amphinemura	2			
Perlesta	47			2
Hydroperla crosbyi	-99			
Isoperla	2			
TRICHOPTERA				
Cheumatopsyche	6			
Rhyacophila	-99			
Hydroptila	14	9		10
Ochrotrichia	1	1		
Oecetis		4		
TRICLADIDA				
Planariidae	5	1		
TUBIFICIDA				
Tubificidae	20	6		33
Branchiura sowerbyi				1
Limnodrilus cervix				1
Limnodrilus hoffmeisteri	6			11
Enchytraeidae	6	3		6

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
VENEROIDEA				
Pisidium		1		4
Sphaerium	6	1		7

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

Aquatic Invertebrate Database Bench Sheet Report

April 1, 2004 - North Fk Spring R [0418702], Station #1

ORDER (Taxa)	CS	RM	SG	NF
"HYDRACARINA"				
Acarina				19
AMPHIPODA				
Hyalella azteca		12		1
ARHYNCHOBDELLIDA				
Erpobdellidae	2	-99		-99
COLEOPTERA				
Hydroporus				2
Berosus				1
Helichus basalis		1		
Scirtes		2		
Dubiraphia				2
Stenelmis	17			
DECAPODA				
Orconectes		1		-99
Orconectes virilis		-99		
DIPTERA				
Ormosia		1		
Ceratopogoninae				33
Simulium	46	200		12
Procladius				10
Cricotopus/Orthocladius	12	68		15
Eukiefferiella	4	1		1
Mesosmittia				2
Hydrobaenus	1	3		7
Axarus	13			
Cryptochironomus				1
Dicrotendipes	2	1		1
Glyptotendipes	4	2		1
Paralauterborniella				1
Microtendipes	3			
Paratendipes	7			3
Phaenopsectra	2			
Polypedilum halterale grp				2
Polypedilum				1
Polypedilum convictum grp	12	4		
Polypedilum illinoense grp	2	3		
Polypedilum scalaenum grp	39			6
Cladotanytarsus	16			13
Rheotanytarsus	1	1		
Tanytarsus		2		6
Thienemannimyia grp.	1	1		
Diptera	2			6
EPHEMEROPTERA				
Acerpenna	1	1		
Caenis latipennis	24	7		34
ISOPODA				
Lirceus	4	28		29
LIMNOPHILA				

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Lymnaeidae	1			
Physella	1	2		1
Helisoma		-99		
Menetus		1		
Planorbella		1		
Ancylidae	3			1
LUMBRICULIDA				
Lumbriculidae	2			
MESOGASTROPODA				
Hydrobiidae	6	1		1
ODONATA				
Enallagma		2		
Nasiaeschna pentacantha		1		
PLECOPTERA				
Perlidae	1			
Perlesta		1		
TRICHOPTERA				
Cheumatopsyche	-99			
Rhyacophila	1			
Oecetis	1			
TUBIFICIDA				
Tubificidae	234			50
Branchiura sowerbyi	1			
Limnodrilus cervix	1			3
Limnodrilus hoffmeisteri	47	1		15
Enchytraeidae	2	1		18
UNIONIDA				
Unionidae	-99			
VENEROIDEA				
Sphaeriidae	39			6
Corbicula	-99			

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

April 1, 2004 - North Fk Spring R [0418703], Station #2

ORDER (Taxa)	CS	RM	SG	NF
"HYDRACARINA"				
Acarina	1	2		1
AMPHIPODA				
Hyalella azteca		7		
Crangonyx	1	2		
ARHYNCHOBDELLIDA				
Erpobdellidae	-99			-99
COLEOPTERA				
Dineutus		-99		
Agabus		1		
Hydroporus	1	-99		7
Berosus				1
Helichus basalis	3			
Dubiraphia		3		1
Stenelmis sexlineata	62	1		
Coleoptera				1
DECAPODA				
Orconectes virilis		-99		
DIPTERA				
Tipula		1		
Ceratopogoninae	4			4
Simulium	18	42		1
Ablabesmyia		1		2
Procladius				49
Corynoneura		1		
Cricotopus/Orthocladius	107	69		4
Diplocladius	6	6		
Eukiefferiella	29	3		
Parakiefferiella	5	10		1
Parametriocnemus	1	1		
Mesosmittia				2
Hydrobaenus	25	31		7
Thienemanniella	1	1		
Endochironomus				1
Chironomus				5
Cryptochironomus				4
Dicrotendipes		2		
Glyptotendipes	3	10		8
Cryptotendipes				6
Kiefferulus				2
Paratendipes	1			15
Parachironomus		1		
Microchironomus				2
Polypedilum halterale grp				16
Polypedilum		1		
Polypedilum convictum grp	19	8		1
Polypedilum illinoense grp	2	18		1
Polypedilum scalaenum grp	13			
Cladotanytarsus	4			1

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Micropsectra		1		
Tanytarsus	6	2		5
Chrysops	-99			
Empididae	2			
undescribed Empididae	1			
Thienemannimyia grp.	3	2		
Labrundinia		1		1
Diptera	1			4
EPHEMEROPTERA				
Stenacron	1			
Stenonema femoratum	4			
Caenis latipennis	20	10		6
Leptophlebia		1		
Paraleptophlebia	1	1		
HEMIPTERA				
Corixidae				5
ISOPODA				
Lirceus	11	30		3
LIMNOPHILA				
Physella	-99	1		
Menetus				1
LUMBRICULIDA				
Lumbriculidae	5	1		
MESOGASTROPODA				
Hydrobiidae	1			1
ODONATA				
Enallagma	1			1
Nasiaeschna pentacantha		1		
PLECOPTERA				
Perlesta	7	6		
Hydroperla crosbyi		-99		
TRICHOPTERA				
Cheumatopsyche				1
Rhyacophila	-99	1		
Ironoquia	-99	2		
Oecetis		3		
TUBIFICIDA				
Tubificidae	94			51
Branchiura sowerbyi				7
Limnodrilus hoffmeisteri	66			20
Limnodrilus claparedianus				1
Enchytraeidae	4			1
VENEROIDEA				
Sphaeriidae	3	-99		8
Pisidium				1
Corbicula	-99			

Aquatic Invertebrate Database Bench Sheet Report

April 1, 2004 - North Fk Spring R [0418704], Station #3

ORDER (Taxa)	CS	RM	SG	NF

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

Branchiobdellida	1	1	
"HYDRACARINA"			
Acarina			45
AMPHIPODA			
Hyalella azteca		4	
Stygobromus			1
ARHYNCHOBDELLIDA			
Erpobdellidae	1	-99	
COLEOPTERA			
Peltodytes		2	
Hydroporus	1	6	6
Scirtes		1	
Ancyronyx variegatus		1	1
Dubiraphia		5	
Stenelmis	81	15	1
DECAPODA			
Orconectes neglectus	-99	-99	
Orconectes virilis		2	-99
DIPTERA			
Ceratopogoninae	2		19
Simulium	41	63	
Ablabesmyia		1	1
Procladius			8
Corynoneura		1	
Cricotopus/Orthocladius	85	52	6
Diplocladius	2		
Eukiefferiella	60	13	
Nanocladius		1	
Parakiefferiella	1	9	
Parametriocnemus	4		
Paraphaenocladius		1	
Hydrobaenus	38	25	24
Thienemanniella	1		
Tvetenia	1	2	
Endochironomus	1		
Chironomus	1		4
Cladopelma			9
Cryptochironomus	5		
Dicrotendipes	5	1	2
Glyptotendipes	6	22	1
Nilothauma		1	
Paratendipes	4		4
Parachironomus		2	
Polypedilum halterale grp			12
Polypedilum	1		
Polypedilum convictum grp	21	6	1
Polypedilum illinoense grp		4	
Polypedilum scalaenum grp	68	2	1

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Stictochironomus	1			
Einfeldia				1
Cladotanytarsus	5			7
Micropsectra		4		
Tanytarsus	3	2		1
Thienemannimyia grp.	4	1		
Diptera				16
EPHEMEROPTERA				
Stenacron	1			
Caenis latipennis	33	28		32
HEMIPTERA				
Trichocorixa		1		
ISOPODA				
Lirceus	1	3		3
LIMNOPHILA				
Physella		-99		
Helisoma		-99		
Ancylidae	2	1		1
LUMBRICINA				
Lumbricidae	-99			
MEGALOPTERA				
Sialis				1
MESOGASTROPODA				
Hydrobiidae	3	3		
ODONATA				
Argia		2		
Enallagma		2		
Ischnura		1		
Nasiaeschna pentacantha		1		
Macromia				-99
PLECOPTERA				
Amphinemura		1		
Perlesta	1			
TRICHOPTERA				
Chimarra	1			
Cheumatopsyche	3	1		
Rhyacophila	1			
Oecetis		5		
TUBIFICIDA				
Tubificidae	37	9		89
Branchiura sowerbyi	11			23
Limnodrilus hoffmeisteri	12	3		11
Limnodrilus claparedianus				1
Enchytraeidae				5
VENEROIDEA				
Sphaerium	15			

Aquatic Invertebrate Database Bench Sheet Report

March 31, 2004 - North Fk Spring R [0418705], Station #4a

ORDER (Taxa)	CS	RM	SG	NF

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

"HYDRACARINA"			
Acarina		2	7
AMPHIPODA			
Hyalella azteca		17	
Crangonyx		1	
ARHYNCHOBDELLIDA			
Erpobdellidae	1	-99	
COLEOPTERA			
Dytiscidae	1		1
Hydroporus		9	7
Scirtes		2	
Ancyronyx variegatus		1	
Dubiraphia		2	
Stenelmis	91	5	3
DECAPODA			
Orconectes virilis		-99	
DIPTERA			
Chaoborus			1
Ceratopogoninae	10		7
Simulium	36	22	
Ablabesmyia		5	
Procladius		1	15
Cricotopus/Orthocladius	80	60	4
Diplocladius		1	
Eukiefferiella	127	9	
Nanocladius		1	
Parakiefferiella	2	4	
Paraphaenocladius			1
Smittia		1	
Hydrobaenus	23	8	24
Thienemanniella		2	
Chironomus			4
Cladopelma		1	8
Dicrotendipes	1	5	
Glyptotendipes	4	10	7
Kiefferulus			1
Paratendipes	8	1	6
Parachironomus		1	
Polypedilum halterale grp			3
Polypedilum convictum grp	11		
Polypedilum illinoense grp	1	7	1
Polypedilum scalaenum grp	1		
Stictochironomus			1
Cladotanytarsus			1
Micropsectra		2	1
Tanytarsus	4	3	11
Nemotelus			1
Clinocera	3		
Thienemannimyia grp.	1	1	

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Labrundinia		3		
Diptera				1
EPHEMEROPTERA				
Caenis latipennis	1	8		5
Leptophlebiidae		3		1
HEMIPTERA				
Trichocorixa		2		
ISOPODA				
Lirceus	1	30		1
LIMNOPHILA				
Physella		21		1
Helisoma		-99		
Menetus		-99		
LUMBRICINA				
Lumbricidae	2	1		1
LUMBRICULIDA				
Lumbriculidae		9		
ODONATA				
Lestidae		1		
Argia		3		
Enallagma		-99		
Ischnura		4		
Basiaeschna janata		-99		
Nasiaeschna pentacantha		1		
Libellula		1		
Pachydiplax longipennis		1		
Perithemis				1
PLECOPTERA				
Leuctridae	2			
Perlesta	23	5		
Hydroperla crosbyi	1	1		
Isoperla	1			
TRICHOPTERA				
Rhyacophila	2	1		
Uenoidae	-99	1		
Oecetis		3		
TUBIFICIDA				
Tubificidae	72	2		89
Branchiura sowerbyi	1			9
Limnodrilus cervix				3
Limnodrilus hoffmeisteri	24			21
Limnodrilus angustipenis		1		
Limnodrilus claparedianus				2
Enchytraeidae	23	1		7
VENEROIDEA				
Sphaeriidae	6	4		8
Corbicula		2		

Aquatic Invertebrate Database Bench Sheet Report

March 31, 2004 - North Fk Spring R [0418706], Station #4b

ORDER (Taxa)	CS	RM	SG	NF

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

Branchiobdellida			2
"HYDRACARINA"			
Acarina		6	6
AMPHIPODA			
Hyalella azteca		23	
ARHYNCHOBDELLIDA			
Erpobdellidae	1		2
COLEOPTERA			
Dytiscidae			2
Hydroporus		3	14
Berosus			1
Tropisternus		1	
Scirtes		1	
Dubiraphia	4	2	
Stenelmis	133	2	6
DECAPODA			
Orconectes virilis		2	2
DIPTERA			
Ormosia	1		
Ceratopogoninae			12
Simulium	72	35	
Ablabesmyia		2	1
Procladius		1	8
Cricotopus/Orthocladius	93	115	25
Diplocladius	1		
Eukiefferiella	41	19	4
Parakiefferiella		2	
Parametriocnemus	1		
Paraphaenocladius		1	
Smittia	1	1	
Hydrobaenus	44	16	25
Thienemanniella		1	
Endochironomus	1		
Chironomus			2
Dicrotendipes		5	9
Glyptotendipes	1	14	10
Cryptotendipes			10
Kiefferulus			1
Paratendipes	9	1	9
Parachironomus		2	
Polypedilum halterale grp			2
Polypedilum convictum grp	22	1	
Polypedilum illinoense grp		2	
Polypedilum scalaenum grp	2		
Cladotanytarsus			2
Micropsectra		2	
Paratanytarsus		2	
Tanytarsus	2		7

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Dolichopodidae	1			
Hemerodromia	1			
Clinocera	3			
Zavrelimyia		1		
Thienemannimyia grp.	2	1		
Labrundinia		1		
Diptera				12
EPHEMEROPTERA				
Acentrella	1	1		
Stenonema femoratum	1			8
Caenis latipennis	2	7		
Leptophlebia		1		1
HEMIPTERA				
Corixidae				3
ISOPODA				
Lirceus		10		
Caecidotea (Blind & Unpigmented)				1
LIMNOPHILA				
Fossaria	1			
Physella		6		7
Menetus		8		1
Ancylidae				2
LUMBRICINA				
Lumbricidae				2
LUMBRICULIDA				
Lumbriculidae				2
ODONATA				
Argia		3		
Enallagma		2		2
Gomphidae				1
Libellulidae				-99
PLECOPTERA				
Perlesta	31			
Hydroperla		1		
Isoperla	3			
TRICHOPTERA				
Rhyacophila	1	-99		1
Oecetis		4		
TUBIFICIDA				
Tubificidae	94	6		37
Branchiura sowerbyi				3
Limnodrilus hoffmeisteri	25	2		18
Limnodrilus angustipenis	2			
Enchytraeidae	7	2		6
VENEROIDEA				
Sphaeriidae	1			38

Aquatic Invertebrate Database Bench Sheet Report

March 31, 2004 - North Fk Spring R [0418707], Station #5

ORDER (Taxa)	CS	RM	SG	NF

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

"HYDRACARINA"			
Acarina	1	1	5
AMPHIPODA			
Hyalella azteca		35	4
Crangonyx		1	
ARHYNCHOBDELLIDA			
Erpobdellidae	1		
COLEOPTERA			
Peltodytes			5
Agabus		3	
Hydroporus		10	34
Berosus	1		
Scirtes		4	
Dubiraphia	1		
Stenelmis	87	1	2
DECAPODA			
Orconectes virilis	1		
DIPTERA			
Erioptera	1		
Hexatoma	1		
Chaoborus			2
Ceratopogoninae	13		9
Simulium	14	5	
Ablabesmyia			2
Larsia	1	2	
Procladius			27
Cricotopus/Orthocladius	89	110	10
Diplocladius	1	1	
Eukiefferiella	129	7	
Paraphaenocladius			2
Hydrobaenus	71	17	27
Cladopelma			11
Cryptochironomus			1
Dicrotendipes	2	1	2
Glyptotendipes	3	6	2
Paratendipes	8		1
Polypedilum halterale grp	1		3
Polypedilum convictum grp	5		
Stictochironomus			2
Cladotanytarsus	1		
Micropsectra	2		
Tanytarsus	3	3	7
Chrysops	4		
Clinocera	4		1
Tanypus			2
Diptera	2		3
EPHEMEROPTERA			
Acentrella	1		
Stenonema femoratum	3		1

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Caenis latipennis	3	6		6
Caenis punctata		6		11
Hexagenia limbata				1
HEMIPTERA				
Trichocorixa		1		16
ISOPODA				
Lirceus	32	102		15
LIMNOPHILA				
Physella	2	2		
Helisoma	-99	1		1
Menetus				1
Planorbella				1
LUMBRICINA				
Lumbricidae	3			
LUMBRICULIDA				
Lumbriculidae		2		
MEGALOPTERA				
Sialis	-99			
MESOGASTROPODA				
Hydrobiidae				1
ODONATA				
Enallagma		3		1
Epitheca (Epicordulia)		1		
Somatochlora		-99		
Libellula				1
PLECOPTERA				
Leuctridae	12			
Perlesta	42	1		1
Isoperla	-99			
TRICHOPTERA				
Rhyacophila	1			
Oecetis		1		
TUBIFICIDA				
Tubificidae	26			74
Branchiura sowerbyi	3			9
Limnodrilus hoffmeisteri	19			7
Enchytraeidae	9	1		6
VENEROIDEA				
Sphaeriidae	6			6
Pisidium	2			

Aquatic Invertebrate Database Bench Sheet Report
March 31, 2004 - Coon Ck [0418708], Station #1

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Gordiidae	1			
"HYDRACARINA"				
Acarina				5
AMPHIPODA				
Crangonyx	3	1		2
ARHYNCHOBDELLIDA				
Erpobdellidae	1			-99
COLEOPTERA				
Peltodytes				1
Dytiscidae	1			1
Agabus		2		
Hydroporus	1	6		18
Dubiraphia	1			
Stenelmis	15			
DECAPODA				
Orconectes virilis	1	1		
DIPTERA				
Tipulidae	1			
Ceratopogoninae	5			8
Simulium	89	8		
Larsia	3			
Procladius				2
Corynoneura		1		
Cricotopus/Orthocladius	120	83		38
Eukiefferiella	47	4		
Orthocladius (Euorthocladius)	1			
Hydrobaenus	44	1		36
Thienemanniella		4		
Chironomus				1
Cladopelma				3
Dicrotendipes				2
Glyptotendipes	3	2		1
Cryptotendipes				1
Paratendipes	4			13
Cladotanytarsus	2			2
Tanytarsus	3			2
Clinocera	6			
Diptera				1
EPHEMEROPTERA				
Acentrella	7			
Stenonema femoratum	1			
Caenis latipennis	5	2		1
HEMIPTERA				
Trichocorixa				10
ISOPODA				
Lirceus	134	189		60
Caecidotea (Blind & Unpigmented)				5
LIMNOPHILA				

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present

ORDER (Taxa)	CS	RM	SG	NF
Fossaria	1			
Physella	8	19		14
Helisoma		-99		-99
Menetus	1			
Ancylidae	1			
ODONATA				
Perithemis				-99
PLECOPTERA				
Perlesta	68	1		
Isoperla	6			
TRICHOPTERA				
Rhyacophila	3	-99		
Ochrotrichia	8	1		
TUBIFICIDA				
Tubificidae	19	6		26
Limnodrilus hoffmeisteri	4			7
Limnodrilus angustipenis	1			
Limnodrilus claparedianus	1			
Enchytraeidae	13	2		21
VENEROIDEA				
Sphaerium	1			1

CS = Coarse Substrate Habitat
NF = Non-Flow Habitat
RM = Root-Mat Habitat
TC = Total Count
* = Present